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Fifty Years Young

By J. B. Tenney

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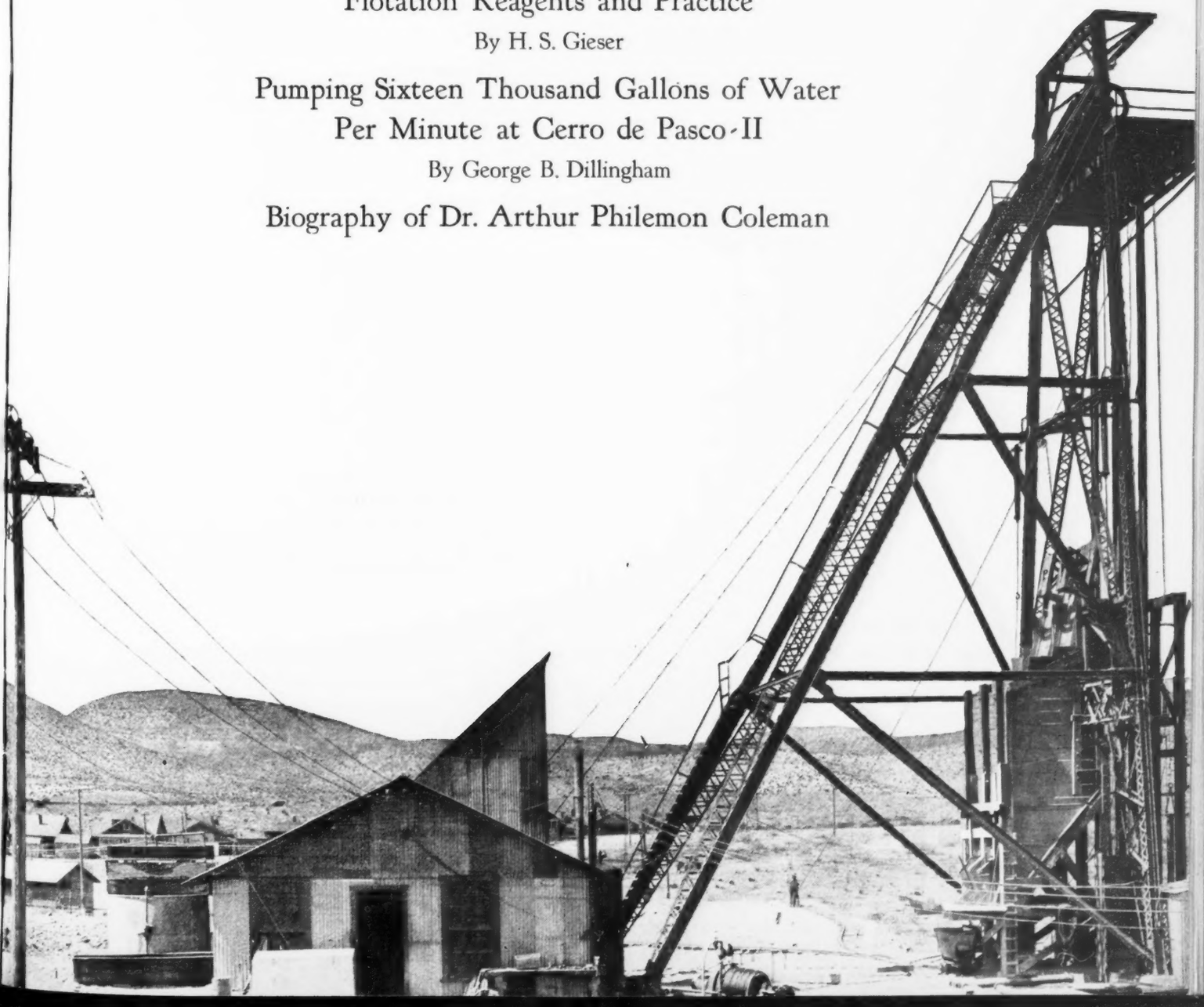
Pumping Sixteen Thousand Gallons of Water
Per Minute at Cerro de Pasco-II

By George B. Dillingham

Biography of Dr. Arthur Philemon Coleman



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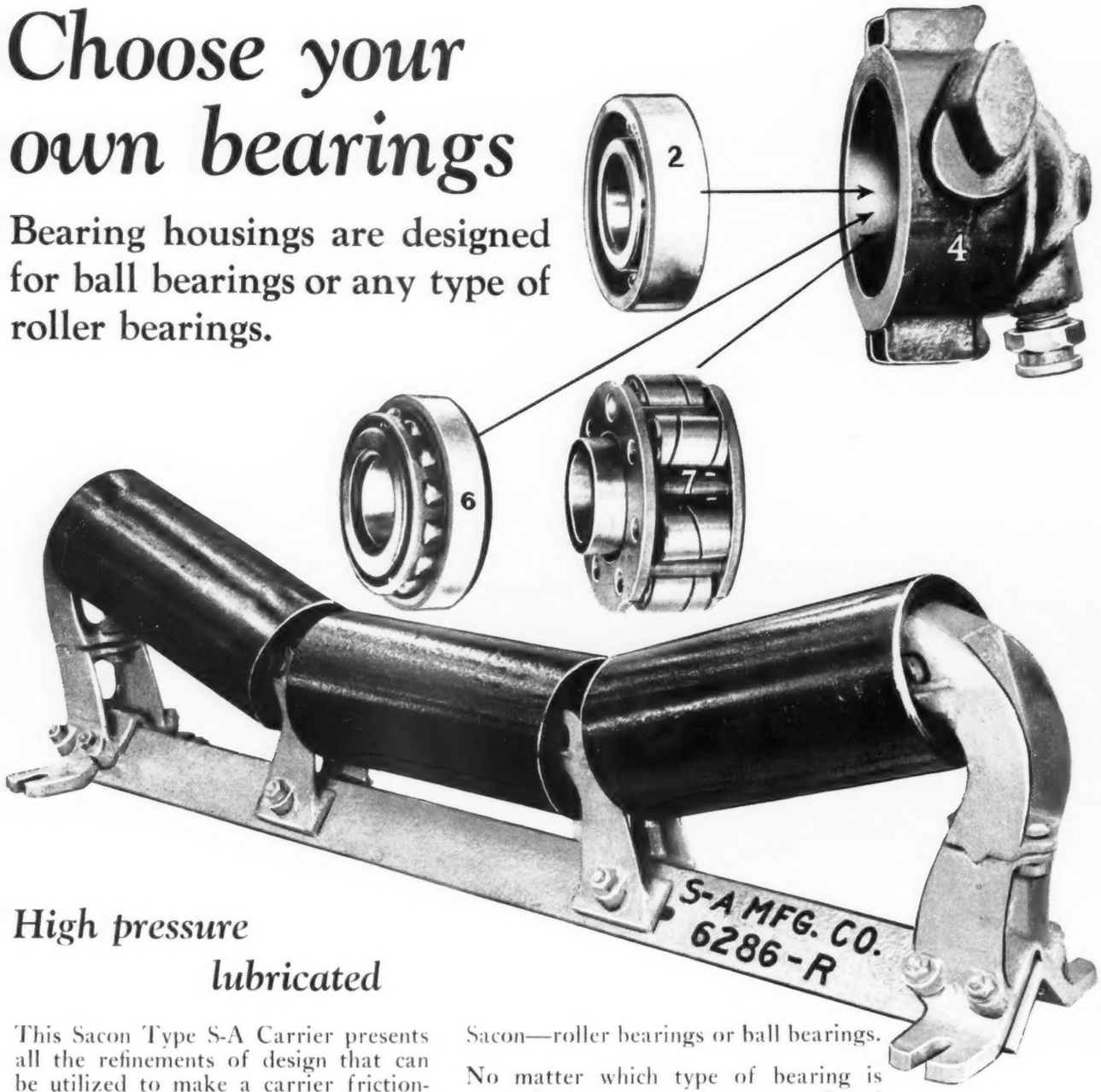

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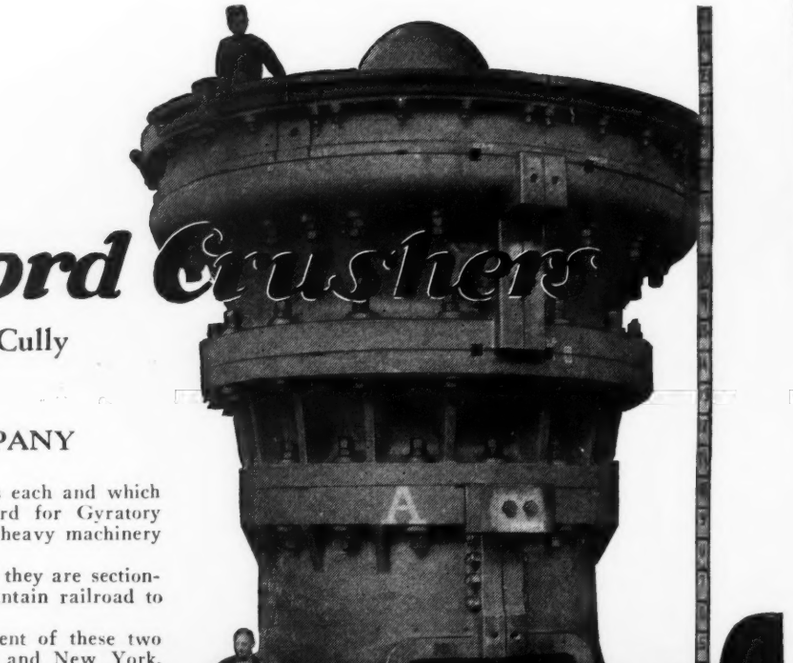
World's Record Crushers



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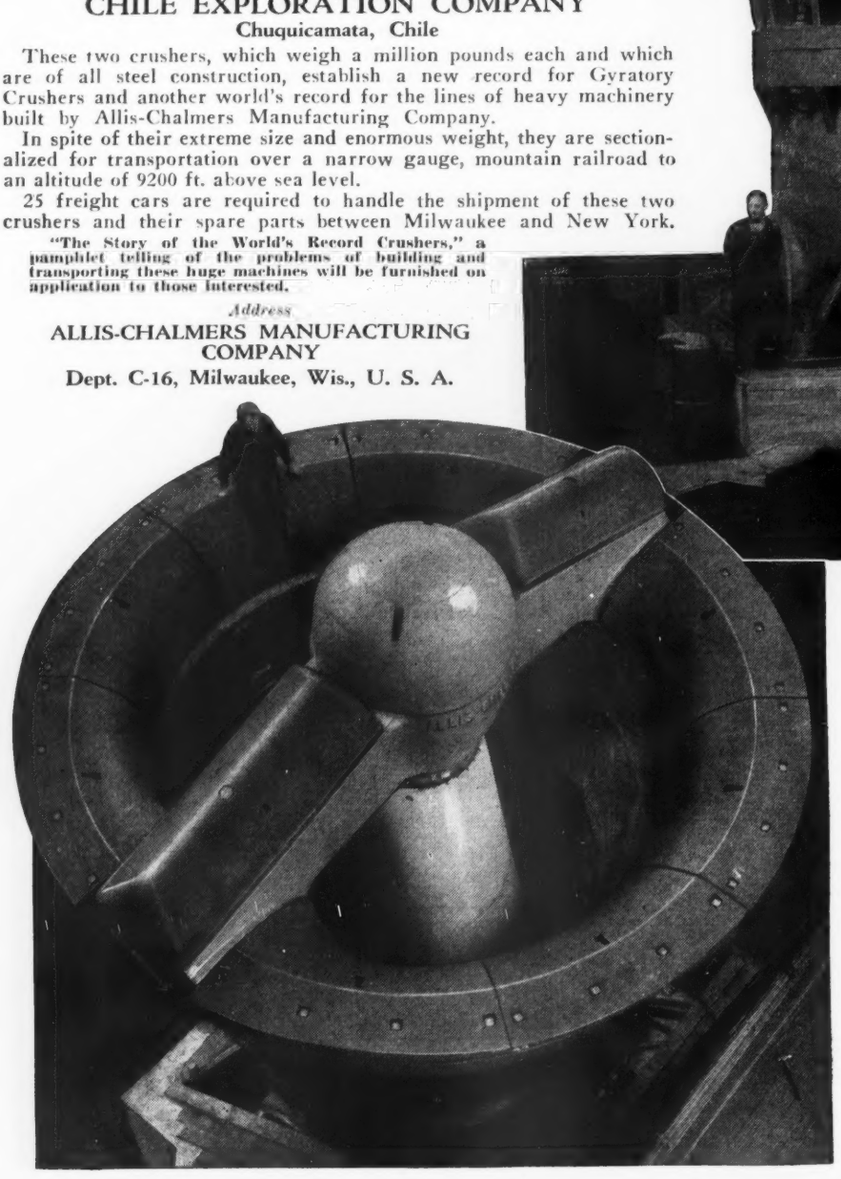

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ENGINEERING AND
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Volume 123 New York, May 21, 1927 *Number* 21

Hand-to-Mouth Buying

HAND-TO-MOUTH BUYING—meticulous analysis may not reveal it as a particularly apt metaphor—is a term used to describe a policy on the part of merchants and manufacturers of carrying small stocks and matching purchases with sales, the merchant for example not carrying large inventories of manufactured goods, nor the manufacturer large supplies of raw materials such as copper, cotton, lead, or rubber. To go a step further, the manufacturer refrains from making purchases in large quantity for forward delivery.

This practice of buying, which has become widely prevalent since the war, has been made possible in large measure by the improvement in facilities of distribution. For one thing, railroad service has been greatly improved; and, perhaps more important, the remarkable expansion in the use of motor trucks—large and small—has made the delivery of sizable tonnages over distances up to 100 miles cheap, reliable, and prompt.

Hand-to-mouth buying has been viewed as one of the most important factors in the complete upsetting of an economic theory of long standing: namely, that widespread industrial activity does not persist during a period of decline in the general price level of commodities. The basis of this reasoning was that, if prices were declining, merchants would strive to resist the trend, thereby contracting their sales; and that they consequently would reduce the size of their orders to manufacturers, who in turn would buy from producers of raw materials in lesser volume. This would tend to result in the reduction of working forces in factories, lumber camps, farms, and mines, thereby diminishing the buying power of the public. All business would become more depressed and prices would be forced down still further. This "vicious cycle" had worked out in practice so many times prior to the war that economists thought that declining prices were incompatible with prosperity.

Under the régime of hand-to-mouth buying the merchant no longer maintains large stocks; as prices decline he sells what he has and must immediately buy more at the slightly lower prices. Stocks are only large enough to meet current demand, and the turnover is rapid. He makes a profit on all of his goods in spite of the declining market. The same thing applies to the manufacturer.

The sufferer, if there be a sufferer, is the producer of raw materials, of which the non-ferrous metals are typical. He holds the bag. He argues that even a good thing can be overdone; and that manufacturers ought to cover the major part of their wants at least a few months in advance. It is evident that if some unforeseen contingency should cut out an important part of the supply of some raw material for any great length of time, the price might rise temporarily to unwarranted levels. Wide and erratic fluctuations benefit no one but the speculators. When producers are anxious in good faith to assist in maintaining reasonable price stability—as is the case with most of the sellers of the non-ferrous metals—consumers might find it to their advantage to co-operate by doing more forward buying than they have in the recent past.

Too Much Petroleum

AT LAST the flood of petroleum caused by unrestricted drilling has grown to such proportions that producers are beginning to yield to Henry L. Doherty's suggestion that something should be done about it. The so-called Doherty plan for conserving oil, which was proposed in 1924, had at that time seemed so likely to put the petroleum industry under government control, if anything like it should be made effective, that the Committee of Eleven of the American Petroleum Institute hastily got out its celebrated report pooh-poohing the idea that production was too great and that conservation was necessary. This report served only to cloud the situation in the eyes of the general public, failing entirely in its purpose to convince the President's Oil Conservation Board, which later declared itself in favor of conservation. Today, thanks principally to the tremendous output of the Seminole field, the total daily production of petroleum in the United States has passed the 2,500,000-bbl. mark. Wherefore it is that the president of the Standard Oil Co. of New Jersey and the president of the Petroleum Institute have besought the Conservation Board to help in bringing about reforms.

These gentlemen propose a certain plan—one that may prevent competitive drilling in new areas to some extent at least, if a way can be found to get around the legal difficulties. To be sure, they evince no enthusiasm for conservation. Their motive is quite different. The upsetting of market conditions by the unprecedented flood of oil has greatly disturbed them, and it is this that they now seek to remedy. But whether production be checked for the purpose of stopping waste or whether it be to maintain a stable market, the result will be the same—namely, the conservation of the United States' rapidly diminishing domestic resources of petroleum. That is the important thing.

The Chinese Problem

ONE SEES A GREAT DEAL about China in the newspapers these days, though the country seems too far away for most of us to take more than a passing interest in the headlines. To mining engineers, the country is of chief interest as a producer of three-quarters of the world's antimony and a consumer of perhaps a quarter to a third of the world's silver. China, with its various dependencies, is a country half again as large as the United States; it probably contains large reserves of coal, copper, and lead and doubtless other minerals, though these are almost entirely

undeveloped. Plenty of hydro-electric power also awaits development. Some day China will be a new hunting ground for the mining engineer, and it is to his interest to keep an eye on what is going on there and support those policies which promise most for its development.

For thousands of years China has been a closed country. A new era seems on the way, and it may not be long now before China will take its place in the world's galaxy of powers, as has Japan since Commodore Perry introduced modern civilization there only seventy years ago. If so, she will be chiefly indebted to Dr. Sun Yat Sen, idealist and first president of the Chinese republic, who died on March 12, 1925. Dr. Sun bids fair to become the combined Washington-Jefferson-Lincoln of China. Upon his death he left a declaration of principles embodying a national entity for China with freedom from foreign control, intervention, and exploitation; a program of educational and political democracy; and plans for the economic improvement of the people. These plans for the development of China as a modern nation of the world were fundamental and of such a character that few unprejudiced observers in foreign countries could take serious objection to them.

To carry out Dr. Sun's ideals, the Kuomintang—literally "country-people-association"—was organized. It is generally known as the Nationalist or Cantonese party. To unite the peoples, it absorbed, or sought to absorb, the various formerly existing factions, among them the Communist group through which Soviet Russia had already sought to make its influence felt in China. Though a comparatively small section of the Nationalist party at first, Communist thought among the Chinese has been carefully nurtured with the unintentional aid of unwise policies by some foreign powers, until the tail has sought to wag the dog. General Chiang Kai-shek, chief of the "moderate" group in the Nationalist party, has now openly broken with the Communist group under the leadership of General Chen Chien, which is in control of Hankow.

But the situation is further complicated. A northern group of Pekingese under the control of Chang Tso-lin refused to join the Nationalist party because they could not stomach its Communist connections. Perhaps now that Chiang Kai-shek has divorced himself of the Communist element, a union may be effected which would make an extremely strong military party. Then there are other war lords—Feng Yu-hsiang, of rather radical tendencies, with an army of perhaps 50,000 in the province of Shansi; and Wu Pei-fu, Sun Chuan-fang, and Chang Tsung-chang, who command chiefly local support and are apparently out for what they can get.

Fighting among these various factions has naturally been prejudicial to the numerous foreign interests, the Communist elements being particularly averse to anything foreign and actually attacking a foreign settlement at Nanking, killing an American. What should the foreign nations do? Plainly they should protect their nationals, but there is no responsible government which can be turned to for redress. They must wait until such a government is formed and in the meantime encourage it to be formed, omitting so far as possible to offer indignities to any of the Chinese people. Cultivation of good will rather than show of force is desirable. The policy of the United States and Japan so far is, in general, to be commended, and European countries seem to be coming to their way of thinking.

The time seems rapidly approaching when China must be treated as a respected nation; when foreigners will have no greater privileges there than in any other country; and the other countries of the world should govern themselves accordingly. Should the Nationalist party successfully divest itself of undue Communist influence, it seems worthy of encouragement. A sympathetic attitude toward China is needed; not intervention to maintain obsolescent privileges.

Collapse of Platinum

WITHIN the brief period of a month the market price of platinum has declined from about $100 per ounce to less than $80. Naturally, buying is demoralized and sales have been small in the aggregate. However, it is probable that a purchaser who is willing to buy in quantity could get metal at $75 or less. Any attempt to prophesy with assurance as to the future course of the market would be foolish. Apparently the factor that weighs heaviest is the effect that a distinctly lower price level would have on the demand of the public for platinum jewelry.

As to the other elements in the problem, there is pretty general agreement. Production is increasing in Russia and in Colombia, and the South African output, which began in 1926, is adding to the world supply. Production costs, at least in Russia and probably in Colombia, are low enough to permit a reasonable profit at a price much below $100 per ounce. Accordingly, a moderate decline would not greatly decrease the world supply, unless a program of deliberate and artificial curtailment were to be launched. The Soviet Government has the industry in Russia under control and could doubtless restrict output if it wished.

The recent break in the market was caused by the adoption of a new policy by the Soviet. Since early in 1926 the product of the Russian mines had been marketed by a German company that operated in close cooperation with a half dozen other interests that together dominated the world situation. It is understood that the Russians were able to produce and wanted to dispose of more metal than the syndicate was able or willing to absorb. Accordingly, arrangements were made to sell directly in either wholesale or retail lots in the New York market. Business had been dull for many months and stocks in the hands of the major interests were large, so that they were not prepared to support the market as they had done on several occasions. Competition developed between the Russian sales agents and the American refiners—most of whose metal is either purchased on a custom basis or is of byproduct origin—and, with consumer buying decidedly small, the price naturally dropped.

Years ago platinum was used extensively in the chemical industries where hot acid liquors were to be handled. Subsequently, however, much cheaper substitutes have been developed. For example, vessels of fused silica, high silicon iron alloys have proved to be amply resistant to both heat and acid corrosion. One field in which platinum still is supreme is in its use as a catalyst, but this does not require quantities in any sense comparable to those formerly used. It is extremely unlikely that any thinkable decline in the price of platinum would stimulate the industrial consumption to any large extent.

There remains the use of the metal in the manufacture of jewelry. Here one has what the logicians call

an imponderable. One manufacturing jeweler has expressed the opinion that with platinum selling at $60 per ounce the market would expand rapidly. Platinum would, for example, compete successfully with white gold. One might argue, however, that the merit of white gold lay in its resemblance to platinum, and that if the vogue of platinum became less, so would that of white gold. This again gets back to the vital question: Is the extremely high price of platinum compared with gold the biggest factor in the high regard it enjoys among women as a material for jewelry? Most people want and are willing to pay for things that distinguish them from the multitude. The higher the price of platinum, the smaller become the ranks of those who can afford to wear it in quantity. To what extent this characteristic of humans influences the market for platinum jewelry no one knows. Most students of the situation take the view that the influence is great.

The remedy of platinum sellers in the past, when the market has become dull, frequently has been arbitrarily to "jack up the price." That course has stimulated buying on many occasions. Platinum is distinctly a luxury commodity, and those producers who think that a lower price level will permit them to increase their sales and their profits may be sadly mistaken. And then again they may be eminently right.

Geneva Looks to the United States

THE European economists and business men at the Geneva meeting, whose conferences are the subject of a special cabled report appearing elsewhere in this issue, appear to be greatly interested in American commercial activity and prosperity, and are anxious to learn what they may do in their own countries to bring about a closer approach to the conditions existing in the United States. Much can be learned that will be of profit to European business men, but conditions are so different in North America and Europe that no short road to prosperity will be found. The immense natural resources of the United States are one of the most important factors. These resources are not entirely the result of prodigality by divine Providence; the comparative youth of the country and the vast extent of territory controlled by one government are important factors. One state alone is larger than the largest country of Europe except Russia, and the total area of the United States is about three times the area of all Europe excepting Russia. If all Europe were under one government, with tariff barriers removed and the free flow of capital possible from one section to another, greater prosperity would almost certainly result. International cartels are a step to this end.

Other conditions, less fundamental, are also different. For example, it may not be to the interest of European countries immediately to adopt the labor-saving machinery and mass production that have been so generally installed in American factories. The United States has a relative abundance of capital and natural resources, and a scarcity of labor. Just the opposite is true in Europe. For the time being Europe should use labor freely and should conserve its limited supplies of capital and raw materials. This means to concentrate on the manufacture of "specialties" rather than to seek prosperity by following the example of the United States. The wise course is to be lavish with the things of which one has much; and to husband those which are scarce.

By the Way

PRODUCTION of crude petroleum being so high that many of the independent companies are threatened with bankruptcy, a high official of Standard Oil called a meeting of executives of some fifteen important producing companies at his office at 26 Broadway. They front-paged the fact and announced that the purpose of the meeting was to discuss ways and means of restricting crude oil output without running afoul of the federal laws against restraint of trade. If they have any luck, a high official on the eighteenth floor just across the street at 25 Broadway might consider calling a similar conference.

THERE are few metallurgical secrets in America, and most smelters are open to any visitors who appear to have the intelligence to comprehend what they see. This is not entirely a charitable attitude on the part of the metallurgists, for the visitor is expected to interchange information, not absorb it. In foreign countries, so they say, a special meeting of the board of directors or something like that is necessary for the stranger to get into most plants. These reflections are brought up by a phrase in an article on "Arsenic Mining in Queensland" in *The Far Eastern Review:* "The ore is broken up to pebble size . . . and then carted off to the works. The process of turning out the pure arsenic, by means of special furnaces, is a carefully guarded secret." It's no secret in the United States, and if it is in Queensland, which is rather to be doubted, the practice there is probably way behind the times.

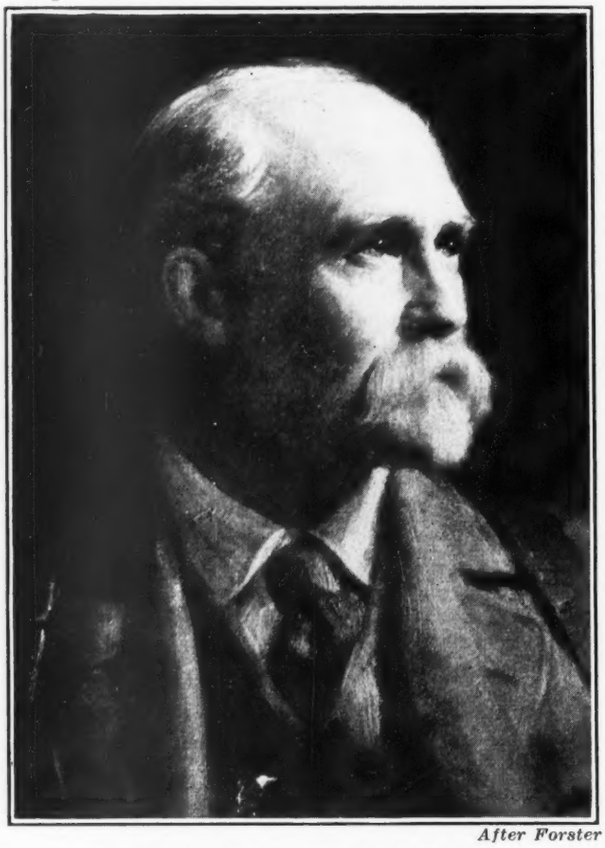
THE "Ask Me Another" craze is beginning to be more of a nuisance than ever. It was hard enough to answer some of the questions when the answers were correct, but when they begin marking one off for not knowing an incorrect answer, it is time to toss the troublesome questioner down the shaft. For instance, *The Industrial Digest*, in New York, has been broadcasting sets of questions by radio, and publishing the questions and answers in its monthly issues. No. 5 in the April list was "What is the chief copper-producing state?" Here, we thought, was where we would get *one* right, anyway. But no, the answer was "Montana." As a matter of fact, Arizona produces almost three times as much copper as Montana, which runs neck and neck with Utah for second place. Not since 1909 has Montana occupied the premier place, and the all-time production of Arizona is now well ahead of Montana, the southwestern state now having produced 11,900,000,000 lb. of copper, or enough to reach easily from here to the moon and back again.

"ALLOW me to congratulate you on your new Indicators of Industrial Activity," says a subscriber in London. These very informative graphs, which appear in this issue on page 868, are of interest to a large number of our readers. Metals and non-metallic minerals are the principal raw materials of industry; with increasing activity in industry, more products of the mining industry will be used. The miner and smelter, the financier who furnishes the capital for them, and the manufacturer who builds their machinery, can therefore study these charts not only to learn how active other industries are but to gage the probabilities and progress of mining activity.

Geologists of Note

Arthur Philemon Coleman

COLLEAGUES, former students and other friends of Arthur Philemon Coleman recently gathered at a banquet in Toronto in his honor. It was the occasion of the presentation to the University of Toronto of a portrait of Professor Coleman, painted by Forster, the Toronto artist. With this was given also a fund for mantaining a gold medal, to be known as the Coleman Medal in Geology and Mineralogy and to be awarded annually to the student graduating with the highest standing in geological and mineralogical subjects. By maintaining it the committee seeks to establish a permanent token of recognition of Dr. Coleman's scientific attainments. Fittingly, the banquet was held in Victoria College, at the University of Toronto, since this is Dr. Coleman's alma mater. Here in 1876 he received his B.A. degree from the school when it was a small college at Cobourg, Ont., and here it was that, after receiving the Ph.D. at Breslau in 1881, he became professor of geology and natural history the following year. This position he held until 1891, when this institution moved to Toronto. For the next ten years he served as professor of metallurgy and assaying in the School of Practical Science of the University and in 1901 became professor of geology and head of the department of geology and palæontology. In 1922 he retired at the age of seventy, older by five years than the age at which members of the staff normally retire. From 1919 to 1922 he was also dean of the faculty of arts, and he now holds the title of professor emeritus in geology. Many honors have come to Dr. Coleman during his long career. He was elected to fellowship in the Royal Society of London and was awarded the Murchison Medal in 1910. He holds the LL.D. degree from Queens and the honorary D.Sc. from both Western University and Toronto. He has served as president of the Geological Society of America, of the Royal Society of Canada, the Royal Canadian Institute, and the Canadian Alpine Club; as chairman of the geological section of the British Association for the Advancement of Science, and as Silliman lecturer at Yale. He has borne all his honors lightly, and his simple life and unassuming manner have made him respected and admired by all with whom he comes in contact. As a lecturer on scientific subjects he is one of the most popular whom Canada has produced, and his writings are widely known. The breadth of Dr. Coleman's interests in geology extends from the Pre-Cambrian to the Recent. He has long been known as one of America's authorities on the Pre-Cambrian shield. His geological work played an important part in the development of the Ontario Bureau of Mines, especially that which he did in the Sudbury nickel field. There are many opinions regarding the origin of the nickel ores, but Dr. Coleman's map of the field and his conclusions are still held valid by most. Despite the fact that Professor Coleman is in his seventy-sixth year he is as active as ever. Since his retirement four years ago he is said to have produced more articles than ever before in a period of equal length. He has traveled widely, and one of the most valuable features of his latest book, "Glaciers, Recent and Ancient," is the personal touch which he brings to the reader from practically every continent where glaciation has been known to exist. Another book, "The Canadian Rockies," gives an insight into his life in the mountains. A third volume, "Elementary Geology," by Coleman and Parks, is a valuable textbook.



After Forster

ARTHUR P. COLEMAN

With all Professor Coleman's interest in geology he has always found time for art. He is an artist of considerable standing, and he has produced in water colors hundreds of beautiful sketches, the subjects for which have been drawn from nearly every corner of the world.

One of Great Britain's best-known geologists says of Coleman, "Not only is he a brave, simple, modest man, but he is one of the great heroic geologists of whom we have now too few. We can class him with the great men of old times such as Logan and Dawson, and with men nearer to us such as Gilbert and Walcott." Such are the tributes to the life and work of a modest scientist, who has sought neither political advantage nor financial gain.

The Bisbee Mining District
Fifty Years Young

By J. B. Tenney
Mining Geologist, Bisbee, Arizona

FOR HALF A CENTURY the Bisbee mining district has enjoyed a period of steadily increased production. The object of this paper is to weigh carefully the evidence, to determine whether the camp has reached its zenith or is to hold its present position.

During the war period the Bisbee district of necessity was worked to its limit, with insufficient development to insure its continuity. During the post-war depression, development campaigns were initiated which partly corrected this condition, but it was not until 1925 that adjustments to meet a continuing low copper market were completed, insuring prosperity for the future.

In this paper certain aspects of the age of mineralization, vital to the further growth of the camp, are considered. The conclusion is reached that the camp on its fiftieth birthday is still in its youth.

Bisbee is situated in the Mule Pass Mountains, a low range of hills 9 miles from the Mexican border, in the southeast part of Arizona. This range, during the Apache Indian domination, was so near the Indian strongholds of the Dragoon and Chiricahua Mountains that it was left unprospected. The first to see the promiment outcrop which gave the camp its start was one Dunn, an army scout. The mountains contained a permanent spring of water, which was used as a stopping place for the army transport trains traveling between Fort Huachuca and Fort Bowie. Dunn's report of the copper showing encouraged one of his hearers, a prospector by the name of George Warren, to make the trip into the mountains. The first location was made in 1877 on what was later known as the Copper Queen claim.

For two years no work was done, as the Mecca of all miners was the near-by rich silver camp of Tombstone, discovered at the same time in 1879. The Copper Queen claim was acquired by a San Francisco company, which erected a small smelter and started mining the rich discovery orebody. Other companies were started at about the same time, but the Copper Queen was the only successful venture.

Early Development

In 1880 Dr. James Douglas visited the camp and acquired the Atlanta claim, adjoining the Copper Queen claim on the south, for the firm of Phelps Dodge & Co., of New York. Considerable money was spent by him—unsuccessfully. In the meanwhile, the discovery orebody proved to be a lens of ore entirely surrounded by barren limestone, and by the end of 1881 it was nearly mined out. The Copper Queen company and the Atlanta company then started to prospect a small stringer of ore leading from the discovery orebody into Atlanta ground, and both companies almost simultaneously penetrated a second rich orebody. To avoid a probable apex suit, the two companies decided to join forces, and founded the Copper Queen Consolidated Copper Co.

The next ten years saw the gradual absorption by the Copper Queen of its weaker neighbors. Transportation was improved by the building of a railroad connecting the camp with the Southern Pacific main line at Benson. The smelting plant was enlarged and improved methods were adopted. From 1890 to 1900 the camp was dominated by the Copper Queen company, which continued to expand its holdings and increase its output. At the end of this period further growth was seen to be impossible without better transportation facilities, and Phelps Dodge & Co. decided to go into the railroad business. A line was surveyed and built between El Paso and Fairbank. After the completion of the railroad it was decided to abandon the smelter at Bisbee, and a larger and more modern plant was built at a selected site on the railroad, 20 miles away, to serve both Bisbee and the company's mine at Nacozari, Mexico. To serve the smelter, a new town was laid out, appropriately named after Dr. Douglas.

Lake Superior Interests Enter Region

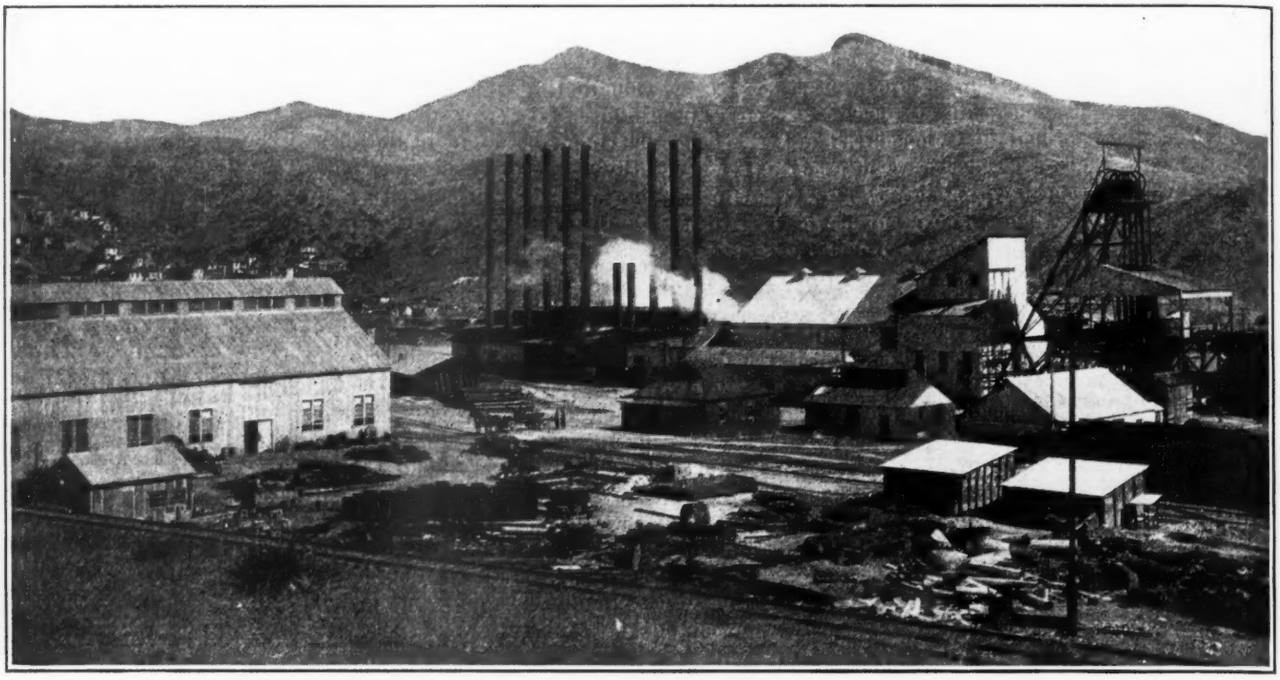
At the beginning of the twentieth century the increased demand for copper caused by the growth of the electrical industry spread the fame of Bisbee, and new capital entered the district from the Lake Superior country. The first of these ventures was the Calumet & Arizona Mining Co., which acquired a group of outlying claims and started a shaft on the Irish Mag. Within a year of starting, a rich orebody was cut, and the new company erected a smelter at Douglas. The same interests then acquired a large group of claims still further out, and started several new companies, all of which eventually proved successful, and all of which were finally merged with the Calumet & Arizona.

Other independent ventures were started during this period, most of which ended disastrously, having insufficient capital. Three survived and are operating today: The Shattuck Arizona, the Denn and Arizona, and the Wolverine and Arizona. The first two were merged as one company in 1925.

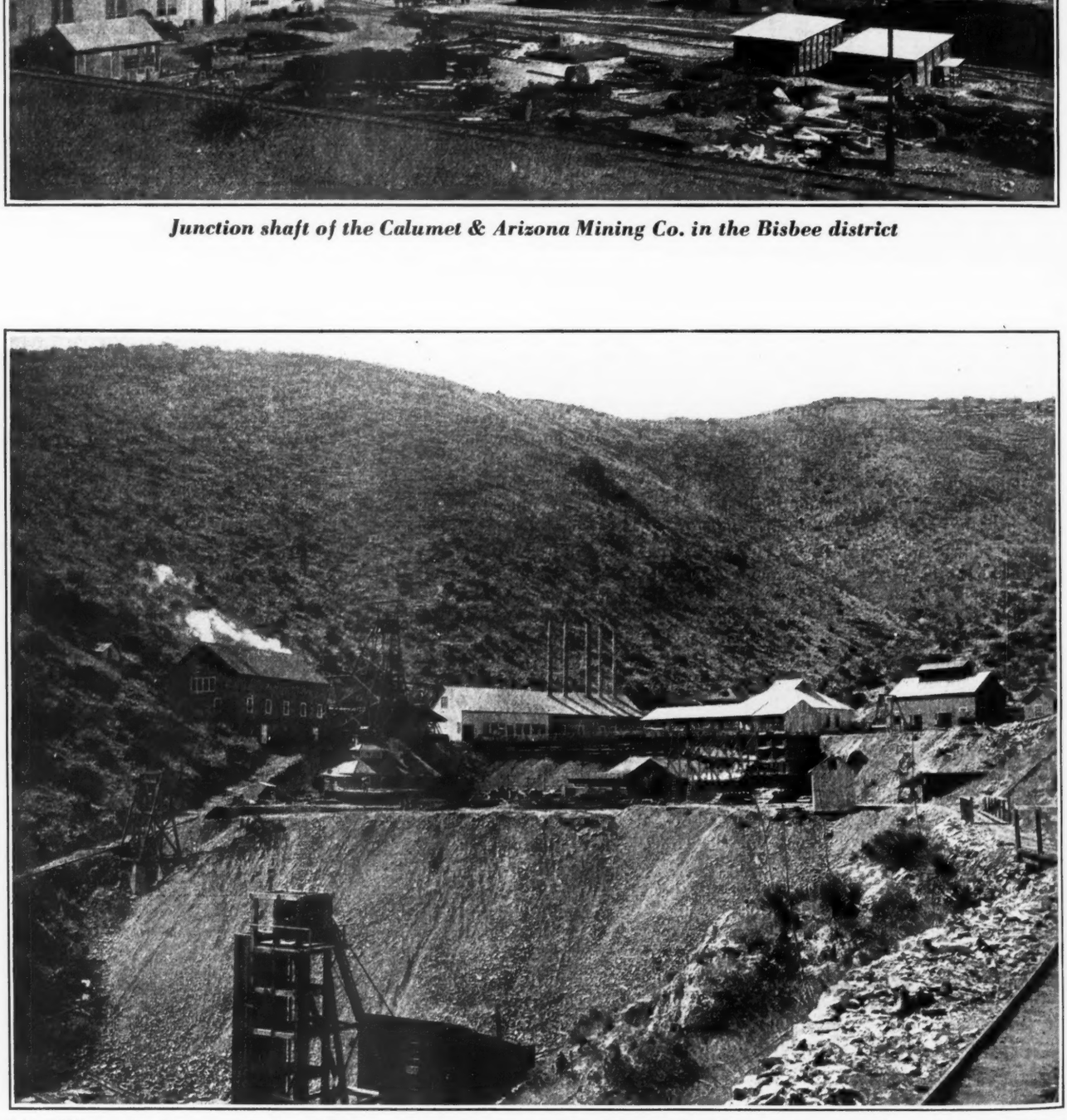
From 1900 to 1925 the holdings of all these companies were exploited, and the Copper Queen developed a large tonnage of concentrating ore in the central intrusive mass of Sacramento Hill. To treat this lower grade ore, a large concentrating plant was built.

Until 1925 the greater bulk of the ore was easily found, and lay in a semicircle around the south edge of the large mass of altered porphyry making up Sacramento Hill. Some prospecting was done in outlying areas, notably at the Shattuck and at the Briggs shafts, and large orebodies were found. At both these and at other places independent centers of mineralization were found, but at all of them the distance from Sacramento Hill was so small that it was not realized that they were independent.

By the beginning of 1925 the Sacramento Hill contract orebodies were practically exhausted. The possibility that orebodies might occur in the outlying area was realized, but the increasing depth at which it was necessary to look for them, and the low tenor of the



Junction shaft of the Calumet & Arizona Mining Co. in the Bisbee district



The Shattuck Arizona shaft at Bisbee. It connects on the 800 level with the Copper Queen's Uncle Sam shaft (seen in the lower left)

primary ore already found, made unattractive the search for new ore of presumably the same grade. It began to look as if the end were in sight. During 1925 the Calumet & Arizona, boldly prospecting to the east, encountered a bonanza orebody in its Campbell shaft, entirely independent of Sacramento Hill, and associated with an independent porphyry mass. This orebody is proving so rich and large that it is giving new impetus to the search for ore in the ground that was viewed with grave misgivings before. Toward the end of 1926 the Copper Queen started a new deep shaft on ground further east than the Campbell, and the Verde Extension Mining Co., of Jerome, acquired a large group over a mile still further east, organized a subsidiary company known as the Bisbee Queen, and started sinking early in 1927. The surface showings, which will be further discussed in a later paragraph, are strong in ground at still greater distances from proved ore. The existence of these strong surface showings, probably indicative of numerous other centers of intrusion and mineralization, and the size and richness of the orebody in the first one found, make it probable that many years of mining activity on the same scale as at present are in store for the district.

The main geological features in the camp have been well covered by F. L. Ransome, of the U. S. Geological Survey, and others, so that only a general résumé will be given here. The major age of mineralization is the only point in question and it will be discussed at greater length.

Deposits Are Replacements in Limestone

The Bisbee ore deposits are irregular replacements of Paleozoic limestones in close association with quartz-porphyry intrusive masses, dikes and sills. Very weak contact metamorphism exists. The mineralization has affected the porphyry as well as the limestone, in places thoroughly sericitizing and silicifying it. In the large mass of Sacramento Hill it is metallized sufficiently to yield a large deposit of disseminated ore. In numerous smaller dikes and sills the ore solutions have converted the porphyry as well as the surrounding limestone into ore. The porphyry in a great many occurrences is fresh and unaltered. Large orebodies are found in limestone at long distances from porphyry. Mineralization was later than the intrusion and solidification of the porphyry. Porphyry contacts are generally favorable loci for ore, showing that the ore solutions traveled up the same paths of weakness as the porphyry, in many instances. They both had the same deep-seated source.

The orebodies are in general flat-lying lenses, dipping with the limestone replaced. Their major dimensions are horizontal. Very few vein-like deposits occur. The average thickness of all orebodies in the district is about 35 ft.

Each individual ore occurrence is in a favorable horizon, bounded by an upper and lower plane, above and below which no commercial ore is found. The thickness of this horizon varies from 100 to 700 ft., with the average nearer the first figure.

The locus of orebodies depends on a variety of factors, chief of which are fracturing and folding, with attendant crushing. Porphyry dikes and sills play an important part in localizing and limiting the ore. In a general way, the best place to search for ore is at the junction of fracturing and porphyry intrusion.

Below the favorable horizon the ore solutions traveled through very insignificant openings, sometimes only knife-blade seams, and dropped only pyrite, silica, and more rarely specularite and magnetite. At the favorable horizon more or less complete replacement of the limestone and porphyry took place, over a wide lateral spread. Large amounts of silica, ferromagnesian silicates, pyrite, and chalcopyrite or bornite were dropped. Above the favorable horizon the solutions traveled up tortuous paths toward the surface, and dropped small amounts of silica, calcite, specularite, manganese oxides, and very small amounts of pyrite and more rarely chalcopyrite or bornite. The surface outcrops are therefore for the most part very small compared with the orebodies with which they connect. A careful study of the surface outcrops of the district has shown that all of the larger orebodies are represented by some sort of mineralized outcrop, usually silica, stained with limonite, specularite, and manganese oxide, accompanied in many cases by veinlets of copper glance. Areas which have been prospected and have proved barren have no mineral outcrops or have very weak ones.

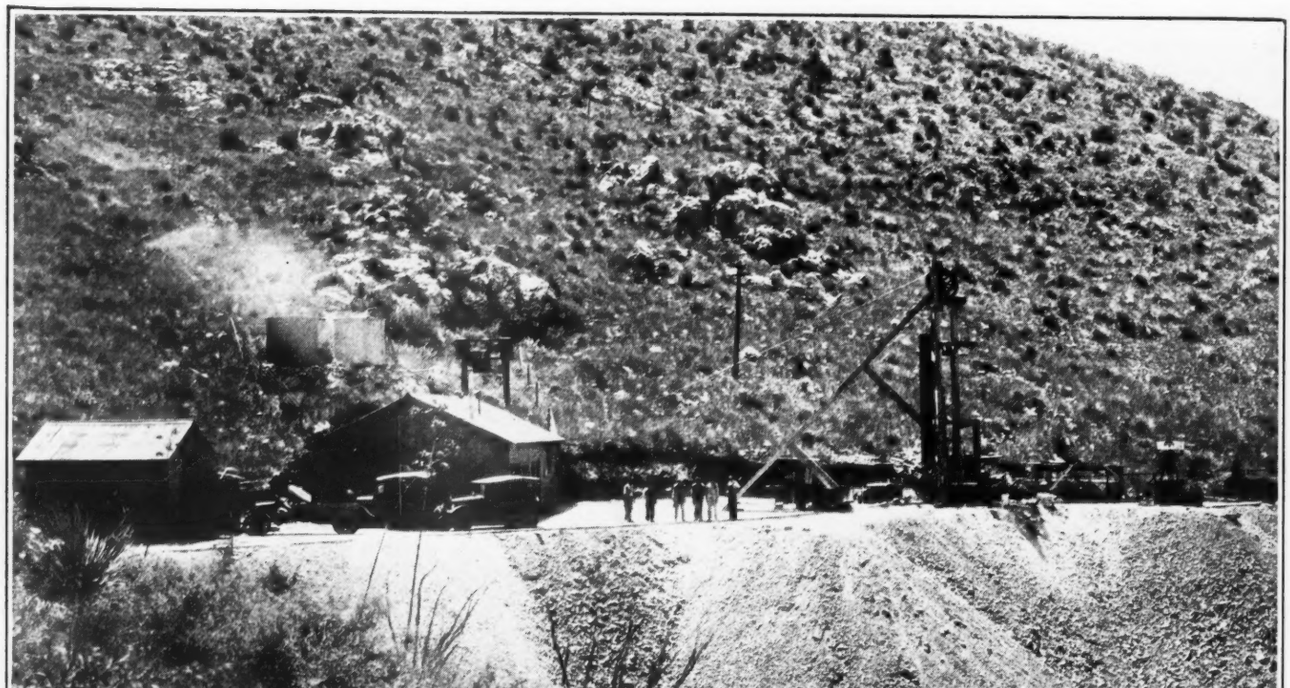
Geologic History in Relation to Outcrops

The general dip of the limestones is to the east, averaging 25 deg., but owing to widespread northeast step-faulting, with the east side raised, the resultant dip is reduced to about 15 deg. Erosion at the western end of the camp has reached or approached the favorable horizon, so that there the outcrops are stronger, and orebodies are exposed. Further east the outcrops become weaker, as erosion has left greater thickness of limestone above the favorable horizon.

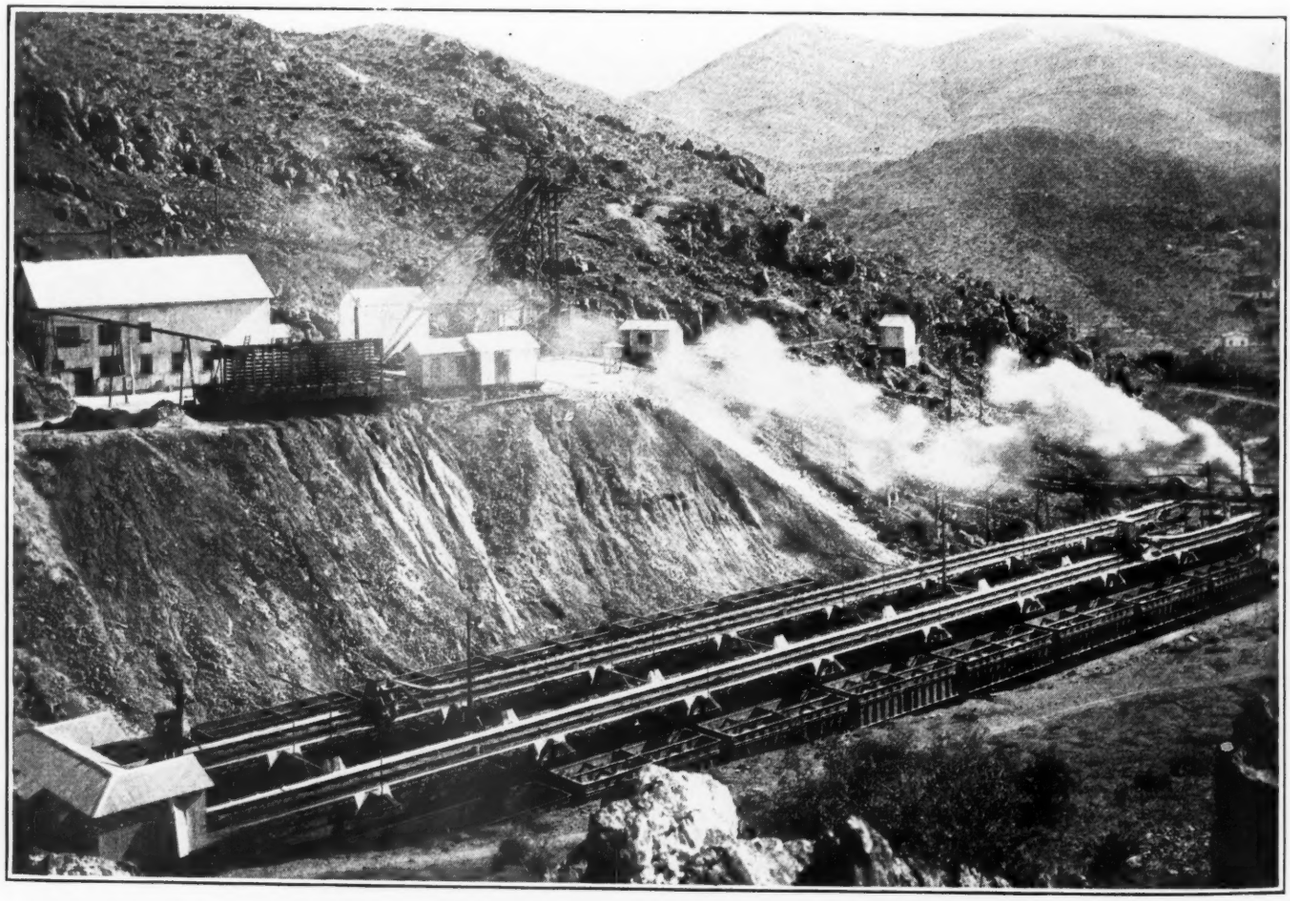
During the Pre-Cambrian an enormous thickness of arenaceous sediments was deposited, later folded and metamorphosed into a quartz sericite schist. The schist was then intruded by a large mass of granite, and the whole subjected to erosion over a long period, reducing the area to a peneplain. Erosion was followed by slow subsidence, with Paleozoic sedimentation starting in Middle and Upper Cambrian time, when 440 ft. of quartzite was followed by 780 ft. of impure limestone. A disconformity exists between the top of this limestone and the overlying shaly limestone of middle or upper Devonian age. Most or all of the Ordovician and all of the Silurian are unrepresented. Devonian limestone 350 ft. thick is followed by 790 ft. of pure limestone of Mississippian age, followed by 3,000 ft. of partly shaly and less pure Pennsylvania limestone. No Permian, Jurassic, or Triassic sediments occur, and sometime during the period the area partook of the uplift affecting the whole of the Cordilleras. Extensive faulting and folding took place. Previous studies of the district have assigned the extensive porphyry intrusion and later ore deposition to this time. The evidence is not entirely clear, but points to the probability that only a small amount of intrusion took place, if any, and very minor mineralization, as will be brought out later.

"Dividend Fault" Divides Ore-Bearing Areas

In the productive area, the dominating structural feature caused by the uplift was a large nearly vertical fault, striking in a general easterly direction, which has been named the Dividend Fault. The south side of this fault was dropped from 1,500 to 3,000 ft. During the long erosion period following, the sediments on the north side were nearly all removed, exposing schist and outliers of quartzite. At the beginning of Comanche, Lower Cretaceous time, erosion had not reduced the area to a peneplain. The Dividend Fault escarpment



Shaft of the Ivanhoe Copper Co., which began developing the Don Miguel group in 1922



Sacramento loading belts of the Copper Queen at Bisbee

still existed, worn down to about 700 ft. Rapid subsidence took place, resulting in the filling of the hollows on the south side of the fault with a very coarse, poorly assorted conglomerate, varying in thickness from a few feet to several thousand feet. The greater part of this conglomerate is made up of schist and quartzite boulders. For a few feet, where the conglomerate overlies limestone, limestone boulders predominate. The material was evidently derived from the north side of the Dividend Fault escarpment. At greater distances from the fault, the thickness of predominantly limestone conglomerate increases, reaching several hundred feet at one exposure, about 2 miles south of the fault. North of the fault the conglomerate is a normal basal conglomerate with well-rounded boulders, and has a maximum observed thickness of about 10 ft.

Various Forms of Occurrences Indicated

The most prominently exposed porphyry mass in the productive area is the Sacramento Hill mass, which ascended as a roughly cylindrical plug, on both sides of the Dividend Fault. The largest exposure is north of the fault. The contacts with the conglomerate and higher beds on this side of the fault have been mapped previously as fault contacts. They can with equal justification be considered intrusive contacts. Evidence supporting the second hypothesis is that the conglomerate is here much more iron-stained than elsewhere, and in places the succeeding sandstone bed is copper-stained.

On the south side of the Dividend Fault, the conglomerate has evidently been removed by erosion from the western part of the productive area, but good exposures of its contact with the porphyry are seen on the southeast flanks of Sacramento Hill. Here the contact is apparently a sedimentary one. The porphyry is here in the form of a wide sill with altered limestones below. The hypothesis is here advanced that the dense, thick phase of the conglomerate deposited south of the Dividend Fault acted as a barrier to the porphyry, giving rise to contacts simulating sedimentary ones. The sill form of the porphyry is very suggestive of this. As further corroborative evidence, a diligent search for porphyry boulders in the conglomerate has been fruitless. A few boulders of fresh porphyry which may be boulders of porphyritic Pre-Cambrian granite have been found, but no boulders of the intensively altered Sacramento Hill porphyry. As the exposed area of porphyry north of the fault is about one mile long by a half mile wide, the absence of boulders in the conglomerate south of the fault is very significant. As further corroborative evidence, in the large exposure of conglomerate made up of predominantly limestone boulders, several miles south of the fault, presumably offering less of a barrier to the porphyry, a number of dikes of porphyry outcrop.

Noteworthy Changes Effected by Geological Epochs

The conglomerate was followed by more than 4,000 ft. of Comanche sediments, predominantly brown and red sandstones and sandy shales, with one thick, pure limestone bed carrying marine fossils. No Cretaceous (Upper Cretaceous) sediments are represented in the district. Sometime during Post-Comanche time, probably during late Cretaceous or early Tertiary, uplift again took place, accompanied by considerable faulting and some proved intrusion of quartz porphyry and andesite. The uplift was accompanied by a general tilting of the sediments to the east, so that erosion taking place from then to the present time has denuded the western part of the productive area of its covering of Comanche sediments.

During late Cretaceous or early Tertiary time, enormous intrusion and vulcanism took place throughout the length of the Cordilleras from Mexico to Alaska. In all the surrounding mountain ranges and mining camps this was the major intrusive age and the major age of mineralization. Cananea, Tombstone, Gleeson-Courtland, Globe-Miami, Superior, and Morenci had their major intrusions at this time, accompanied by ore formation. The Paleozoic-Comanche or Paleozoic-Cretaceous unconformity exists in all of them not accompanied by intrusion or mineralization. All of them also show the Paleozoic sediments to be the best hosts for ore.

Pre-Comanche Mineralization

Some copper mineralization took place before the deposition of the Comanche conglomerate. In the best exposure of conglomerate made up of predominantly limestone boulders, about two miles southeast of the town of Warren, numerous boulders of limonite, limonite-stained quartz, and occasional small boulders of copper glance occur, derived without question from a mineralized land mass. This is the only locality in which mineralized boulders occur in the conglomerate. No porphyry boulders are found here.

Post-Comanche Mineralization

The tilting to the east, accompanying the last uplift, has caused subsequent erosion to strip the Comanche sediments from the western part of the productive area. East of Sacramento Hill the conglomerate has been left. In this large area of conglomerate numerous islands of Paleozoic limestone occur. In the western part of the district the age of mineralization is not subject to proof. In the eastern part mineral outcrops are numerous in the limestone islands, in the form of silicification accompanied by limonite, manganese oxide, and some copper stain. In every case where these mineral outcrops extend to the edge of the conglomerate, they penetrate the conglomerate for several feet. The conglomerate acted as an effective bar to the rise of the mineral solutions, except where it was formed of limestone boulders.

The mineral outcrops east of Sacramento Hill are identical in appearance to those in the western part of the district. One of the stronger outcrops is associated with a large Post-Comanche fault. This is the one over the bonanza orebody at the Campbell shaft. Quartz veins and silicification accompanied by copper glance and limonite occur penetrating all the Comanche beds, the highest observed outcrop being more than 3,000 ft. above the top of the conglomerate.

The evidence is strong that although some mineralization took place in Pre-Comanche time, the major intrusive age and therefore the major age of mineralization was late Cretaceous or early Tertiary, conforming to the age in all the surrounding camps. If this conclusion is correct, the outcrops to the east of Sacramento Hill, all of which are Post-Comanche, are just as indicative of orebodies as those that appear to be of doubtful age and which occur in the western part of the camp where the Comanche sediments have been removed.

Flotation Reagents and Practice

A Review Showing How the Selective Separation of Minerals Is Being Accomplished

By H. S. Gieser
Winthrop, Calif.

H. S. Gieser

THE PROGRESS of flotation in the last few years has been so rapid, and some of the large-scale developments have been so important, that many mine executives are closely scrutinizing their milling methods to see if selective flotation cannot advantageously be applied to their plants. Not many years ago the separation of galena and sphalerite was successfully accomplished for the first time by flotation; now copper concentrators are discarding worthless pyrite and others are separating chalcopyrite and galena, greatly increasing the returns. The published results of this work are so scattered, so many of the processes are patented, and the different plants are so widely separated, that the following review of the literature, with personal comment, is offered busy operators.

Selective flotation is a delicate process, and success can be attained only by careful attention to keeping conditions constant. Of prime importance are: (1) Steady feed, (2) pulp density, (3) fineness of grinding, (4) amount and constancy of oils and reagents, and (5) the place where they are added and the time for the conditioning of the pulp.

Steady feed is necessary for acceptable results in any flotation process. This can easily be accomplished by mechanical feeders from a fine-ore bin, with the aid of a surge tank to take care of slight inequalities.

Pulp density is a matter too often neglected. It is not an easily visible factor, and a criteria of its effects can be obtained only by careful long-time sampling. In practice the dilution of the pulp is usually regulated to maintain the fineness of grinding found necessary. Careful testing has shown that grinding efficiency should be sacrificed to a certain extent to maintain the proper pulp density. Selective flotation is commonly carried out in a pulp density of 25 to 30 per cent solids. At a number of mills where creditable results are obtained pulp-density indicators are in use and are closely watched.

Microscopic study has shown that many ores must be finely ground to liberate the different minerals so that satisfactory recoveries and high-grade products may be obtained. Some of the mills are grinding to a fineness so that 60 to 90 per cent of the material will pass 200 mesh. A detailed study of the results obtained in cyaniding will show that the tube mill is eminently fitted for this work.

The day of the drip can in flotation is past, for oils and reagents should be added in unvarying amounts. The newer mills are installing devices whereby a wide and positive variation in reagent feed can be maintained.

Flotation oils, so called, or agents, a number of which are not oils at all, as distinguished from conditioning reagents, are invariably organic compounds. They are either capable of forming a froth or have the property of attaching the mineral particles to the froth, or both. Flotation conditioning reagents are generally inorganic compounds which affect the mineral particles in some way, probably by depositing a film or tarnish upon them so that the one or more desirable minerals in an ore may be floated in advance of the others. Some have an effect on surface tension. The inorganic compounds are generally added ahead of the flotation cells—frequently to the ball-mill circuit. In selective flotation, several of the reagents are slow acting, and time is necessary for the desired or conditioning effect to take place, so the pulp and reagents are agitated in one or more emulsifier tanks. This is frequently the practice after one mineral has been removed, to prepare the pulp for floating another mineral. The oils or agents, unless they are thick and heavy like the tars, may be added to the flotation cells or emulsifiers. When xanthate is used it works best when a small amount is fed to each cell.

Some of the plants doing good work on zinc-lead separation make a bulk concentrate and a tailing, which is rejected. This concentrate is treated in a separate flotation machine, the zinc is depressed, and the lead is floated and removed, the zinc being in the tailing of that machine. This circuit gives a lower reagent cost, and probably a lower general tailing. Other plants have difficulty in depressing the zinc once it has been floated, so they depress the zinc first, take off a lead concentrate in a primary flotation machine, and then float the zinc in a secondary machine. Sphalerite is a contrary mineral. Both the lead and copper smelters penalize an excess of it, and the zinc retorters want no lead or copper in the concentrate that they buy, and will pay very little or nothing for them when present.

The following table is taken from Bulletin No. 17, University of Utah, with a few inclusions by myself:

Relative Floatability Table

Limestone	2.4
Quartzite	5.3
Quartz—SiO_2	10.7
Sericite	12.7
Calcite—$CaCO_3$	18.5
Kaolinite—$H_4Al_2Si_2O_9$	60.0
Pyrrhotite—FeS	
Antimonides	
Arsenides	
Pyrite—FeS_2	62.0
Pentlandite—(FeNi) S	
Chalcopyrite—$CuFeS_4$	66.0
Covellite—CuS	70.0
Bornite—Cu_5FeS_4	85.0
Sphalerite—ZnS	87.0–62.0
Tetrahedrite—$Cu_8Sb_2S_7$	
Galena—PbS	92.0
Chalcocite—Cu_2S	93.0
Stibnite—Sb_2S_3	
Molybdenite—MoS	
Graphite—C	

Conditioning Reagents

Lime—CaO
Sodium carbonate—Na_2CO_3; sodium bicarbonate—$NaH\ CO_3$; soda ash—Na_2CO_3
Sulphuric acid—H_2SO_4
Sodium hydroxide—NaOH
Sodium cyanide—NaCN — Black cyanide—$Ca\ (CN)_2$
Zinc sulphate—$Zn\ SO_4+7H_2O$
Sodium sulphide—Na_2S — Black ash—BaS
Sodium sulphite—$Na_2\ S_2\ O_3$
Sodium dichromate—$Na_2\ Cr_2\ O_7$
Sodium silicate—$Na_2\ SiO_3$
Copper sulphate—$CUSO_4$

Flotation Agents

Pine oils
Cresylic acid
Coal tars
Water-gas tars
Coal-tar creosotes
Hardwood creosote
Thio-carbanilid — T-T mixture
Xanthate

Conditioning Agents

Lime is the most important alkaline reagent employed in flotation today; it is generally cheap and abundant and as its positive action in depressing pyrite is becoming better understood, more plants are adopting it. The rejection of barren pyrite in the concentration of copper ores by the use of lime and the T-T mixture or xanthate has made profitable the treatment of lower-grade ores and has enabled mines to keep operating which would otherwise be forced to discontinue during the present low price of copper. It is generally used on copper ores, but frequently excellent results can be obtained on lead-zinc ores. The amount to use will vary in individual cases, but is generally critical, probably not over one pound per ton of solution being sufficient. The alkalinity is carefully controlled by half-hourly titrations with standard acid using phenol-phthalein as an indicator. High alkalinity will depress galena, but has not so harmful an effect on the sphalerite, though more xanthate will be needed.

The treatment of water used in flotation should be given careful study. Published results of work done at Cananea prove conclusively that the control of soluble salts was absolutely necessary before successful selective flotation could be applied, and in the treatment of tailing piles and slime ponds the question of soluble salts is serious. Fortunately, lime is a cheap and efficient reagent for combating this evil.

Soda ash, or sodium bicarbonate, is usually employed as the alkaline reagent in galena-sphalerite separation. Five pounds to six pounds per ton of ore is common practice. Soda ash with oils has a selective action on galena, but some more positive reagent is usually employed in addition.

Sulphuric acid was formerly employed in zinc flotation to a considerable extent, but an alkaline pulp is now generally employed.

Sodium hydroxide is used to a certain extent in zinc-lead separation to counteract the effect of the oils used in floating the lead.

Sodium sulphide prevents sphalerite from floating, but has a slight tendency to float pyrite. In one case lime and sodium sulphite were added and ground in contact with the ore in a ball mill. After flotation of the lead the pulp was thickened to eliminate the bulk of the lime and sulphite. The pulp was then diluted with fresh water to the required density and soda ash, copper sulphate, and oil were added for removing the zinc. At Sunnyside, Colo., marked success has been obtained by using sodium sulphite in a circuit with soda ash for depressing the sphalerite. Too much sulphite inhibits everything from floating.

Sodium silicate is much used in lead and in zinc-lead flotation. It aids in giving a brittle froth, which is helpful in eliminating the "insoluble." It has a beneficial effect on slightly oxidized sulphides, permitting them to oil better and thus speed up flotation. An excessive amount should be avoided, as too brittle a froth drops sulphides.

Sodium acid phosphate, the permanganates, and complex cyanides have been used in the laboratory for depressing sphalerite. Chromic acid and some of the chromates are depressors of galena. The sodium salt is effective and cheaper and its use for separating galena and chalcopyrite deserves serious study. Potassium dichromate in an acid solution 0.1 to 0.15 c.c. of sulphuric acid to 1 gm. of the salt quickly turns galena yellow, perhaps forming lead chromate. It also tarnishes pyrite slowly, thus inhibiting its flotation. It is used at the Consolidated Mining & Smelting Co. in Canada, presumably for eliminating pyrite. Some of the cadmium salts are depressors of galena. Chlorine gas has a depressing effect on sphalerite, and sulphur dioxide has been used on a working scale, but the mechanical handling of gases is difficult.

Cyanide in Flotation

The use of cyanide, developed by Sheridan and Griswold at Timber Butte, depends on the fact that the addition of a small amount of an alkaline cyanide in a circuit with an alkaline salt deadens the sphalerite so that galena or other sulphides can be removed in advance of it. It has been shown under the microscope that a coating has been deposited on the sphalerite particles which probably retards their floatability. A few tenths of a pound per ton of ore is ordinarily sufficient, and it is commonly used with soda ash or sodium bicarbonate. Sometimes the pulp need not be alkaline, but at the Utah-Apex mill an alkaline pulp is necessary. I am familiar with an ore upon which good results were obtained with two pounds per ton of soda ash, though comparable results were obtained on the same ore using a lime circuit.

Tucker and Head have shown in a series of carefully prepared experiments that in an alkaline circuit the addition of one pound of cyanide per ton of ore has but little effect on the galena, retards the flotation of the sphalerite, and depresses the pyrite to a great extent. There is some disagreement as to the effect of cyanide on copper minerals. Only 0.6 lb. per ton of ore is used at the Utah-Apex mill for depressing copper. It has also been used at the International plant at Tooele for the same purpose.

An alkaline cyanide in an alkaline circuit in conjunction with zinc sulphate has an even more positive effect on depressing sphalerite, and less so on pyrite. Two commercial varieties of zinc sulphate are on the market. One is $ZnSo_4 . 7H_2O$, the other $ZnSO_4 . 2H_2O$. Approximately three parts of the former to one part of sodium cyanide, and two parts of the latter to one part of the cyanide, will give a cream-colored precipitate of $Zn(CN)_2$ soluble in an excess of the cyanide. In plant practice the two may be mixed and fed to the ball-mill circuit. When the precipitate appears somewhat gelatinous the proportion of each is correct. Erratic results were obtained at Anaconda and other plants until the correct proportion of these was added.

Zinc sulphate alone is a depressor of sphalerite, but does not seem to be much used in practice. At a number

of plants a good separation of galena and sphalerite is obtained with cyanide alone; others use the cyanide zinc-sulphate combination. At Anaconda, with a bulk float, high-grade concentrates are obtained with a good recovery by using the combination. Other plants have difficulty in depressing the zinc.

Cyanide has another important use in the flotation of copper ores high in pyrite. In one instance, by the addition of a small amount of cyanide in an alkaline circuit, a high-grade copper concentrate was produced and the major part of the iron eliminated. In another, in treating a copper-lead-zinc-iron ore, cyanide was added to the zinc cleaner cells, and beneficial results were obtained in eliminating the pyrite, thus making a higher-grade product. When the continued use of cyanide in zinc cleaner cells is not necessary, at times the froth accidentally gets full of pyrite, and the addition of a little cyanide quickly depresses it, thereby enabling the operator to get his circuit back to normal in short order.

Sodium sulphide aids in the flotation of oxidized lead and copper minerals by giving them a superficial film of sulphide. It has also been used for removing a film or tarnish from sulphide minerals so that better recoveries may be obtained. Pyrite is the most difficult common sulphide to float, and sodium sulphide is a valuable aid. It has been known for a number of years that sodium sulphide had a depressing influence on sphalerite, but it remained for Hellstrand to adopt it commercially at the Timber-Butte mill. It can be used to separate copper, lead, and iron from zinc. An ore that was slightly tarnished from the Sullivan mine was tested. Sodium sulphide increased the recovery of the lead, but more iron came with it; also, more iron tended to float with the zinc. One to six pounds per ton of sodium sulphide is generally sufficient.

By the Hellstrand process more iron enters the lead concentrate, and iron is generally in demand by lead smelters; but there is more bulk, and so freight and treatment charges are higher. Also, the lead concentrate may carry a greater total quantity of zinc. Reagent cost is lower. Sodium sulphide in excess depresses galena; also silver sulphides. The cyanide process has a much wider application than the sulphide process.

At the Shattuck Denn property, in Arizona, two pounds of sodium sulphide per ton of ore is used for sulphidizing a lead carbonate ore with a siliceous gangue. Best results were obtained by the addition of sodium silicate, xanthate, Lewis tar, and No. 70 frothing oil. Sodium silicate, xanthate, and part of the tar and frothing oil are added to the ball mill; sodium sulphide and the remainder of tar and frothing oil to the mixer. Xanthate steadied the results. Among other things, it was found that a delay in the application of sodium sulphide was not necessary; that the use of sodium silicate reduces the amount of sodium sulphide necessary and makes a higher-grade concentrate; that flotation of lead carbonate ores is as much a matter of skill and experience of operators as of the type of flotation machine used, though mechanical air machines are preferred; that the character of the water used was important; and that excess of iron in the water was detrimental to both lead and silver recovery.

Barium sulphide, or black ash, an intermediate product of the lithopone industry, has been used with some success as a sulphidizer. It is used as a deflocculator at the Silver Dyke mill, in Montana.

Copper sulphate is one of the most valuable reagents used in zinc flotation today. It aids in giving a higher recovery and the addition of the correct amount gives a clean zinc concentrate. Too much causes the pyrite to float. It is valuable for reactivating sphalerite after flotation of the lead or copper.

In the selective flotation of chalcopyrite and nickel minerals in the presence of pyrrhotite the essential requirements are the same as in eliminating pyrite—namely, pulp made alkaline by lime or soda ash, and the new flotation agents. The chalcopyrite floats with more ease than the nickel minerals.

FLOTATION AGENTS

Steam-distilled pine oil is the most universally used frothing agent in flotation, and is the standard by which other oils are compared. On many ores no other oil or reagent is required.

Cresylic acid is much used in lead flotation. It has selective properties, but is not a good collector. It has less tendency to float pyrite than pine oil.

Coal tars formerly had a wide application in flotation, but are not used so much now. They are generally good collectors, but have a tendency to raise too much gangue.

Water-gas tar is used somewhat in zinc flotation to assist in cleaning the tailing.

Many kinds of creosotes have been used in flotation—coal-tar creosotes, hardwood creosotes and compounds from pine-wood oils. The most valuable coal-tar oils are those that contain a high percentage of the tarry acids such as phenol and cresol. Barrett No. 4 is perhaps the most popular; it has been used with success on many kinds of ores, generally in conjunction with pine oil. Hardwood creosotes like Cleveland-Cliffs Iron Co.'s No. 2 have been used for many years. They are good frothers and fair collectors and have had a wide application, particularly on lead. Some of the heavier Barrett oils, notably No. 634, are valuable in assisting to make a clean zinc tailing.

Many of the cheaper collecting oils, like crude mineral oil and shale oil, have a large local consumption.

Formerly large quantities of kerosene acid sludge were used in copper and zinc flotation, notably at Anaconda. It is a waste product from the refining of kerosene by the use of strong sulphuric acid and contains unstable complex hydrocarbons and sulphuric and sulphonic acids. It was early recognized that it was the sulphur present that gave it the "kick." So, many oils were compounded and treated with sulphur, both in an open and a closed still. These are known as reconstructed oils and were used with marked success by the large copper companies of Utah and Arizona for years. The following will serve as an example: A charge consists of 1,050 lb. of blast-furnace oil, 150 lb. pine oil, and 50 lb. of sulphur. The pine oil and part of the blast-furnace oil are placed in a still; then the sulphur is washed in with the balance of the blast-furnace oil, and slowly fired in a low-pressure still until a pressure of 7 or 8 lb. is obtained, which is held for eight hours. Such products are unstable.

Many organic compounds containing sulphur were systematically tested for flotation purposes, notably by the General Engineering Co. and Minerals Separation. The first to attain prominence was a coal-tar product, thio-carbanilide, or technically, diphenylthiourea ($CH_3C_6H_4NH_2$), which is a powder and dissolves with

great difficulty in water. Small amounts are added dry in the ball-mill circuit, where it possesses powerful collecting properties, but has a tendency to float gangue. Its principal application is when dissolved in the proportion of about one part thio-carbanalide in four parts ortho-toluidine, a liquid. It is then known as T-T mixture. The mixture must be heated to about 80 deg. C. for several minutes and kept warm. It has only weak frothing power and is generally used with pine oil. T-T mixture is used on many different ores. It is very selective as regards pyrite, enabling high-grade products to be made with good recoveries. It finds wide application in the copper and lead-zinc field where the improved results justify its higher cost.

Sodium xanthate is the most universal flotation agent in use today, being applicable to most ores. It was developed by Minerals Separation in a systematic investigation. It has the formula $CS(OC_2H_5)SNa(?)$ and is made commercially by mixing caustic soda, alcohol, and carbon bisulphide in molecular proportions. It is readily soluble in water and used in various percentages. Sodium xanthate in a lime circuit is used in many of the copper concentrators of the country, with such variations as local conditions demand. It is not very selective toward pyrite, and so must be used sparingly, a little to each cell. Properly adjusted it gives a high-grade concentrate and a low tailing. It is largely used in zinc flotation, frequently with the addition of an oil to clean the tailing. For instance, Anaconda uses xanthate and Scotch blast-furnace oil on the zinc; other mills use xanthate and water-gas tar or Barrett No. 634.

Considerable of the success of selective flotation has been due to the T-T mixture and xanthate, as they are not so sensitive to changes as oils alone and exceedingly careful manipulation is not required.

The American Cyanamid Co. has recently introduced a new flotation agent, phospho-cresylic acid, which consists essentially of high-grade cresylic acid reconstructed with phosphorus pentasulphide. It was developed in an investigation by the Utah Copper Co. for an agent that would float copper and reject pyrite. The company claims it will do this with copper, lead, and zinc. If true, it will be welcomed by many mill superintendents who have an excess of barren pyrite.

Utah-Apex uses a General Engineering Co. compound, known as T-A mixture, thioureas dissolved in analine. It has the advantage over the T-T mixture of not crystallizing at ordinary temperatures.

Floatability of Gangue Minerals

In a pamphlet recently issued by the School of Mines, University of Utah, is recorded the results of some very interesting experiments on the flotative properties of a few common gangue minerals. Some of the reagents used in practice were added to quartz and calcite, among others, both alone and with added galena. The results indicated that lime increases the floatability of quartz to quite an extent, but decreases that of calcite. Calcium chloride decreases the floatability of quartz. Sodium salts are depressors of both quartz and calcite, some being more effective than others. On a mixture of galena and a gangue mineral, the results are somewhat different.

In general, reagents have different effects on the floatability of gangue and valuable minerals. Sometimes they depress the gangue and do not affect the desired mineral. In other cases they depress the desired mineral and do not affect the gangue, and in still other instances they depress the desired mineral and raise the gangue. Ordinarily more gangue is floated when a sulphide is present.

Last year the U. S. Bureau of Mines published a paper on the flotation of limestone from siliceous gangue. Good results were obtained with about equal proportions of oleic acid and cresol, no reagent being added.

It is plainly evident that more attention should be given in flotation testing to the behavior of the reagents on the gangue minerals of the ore being tested. If a cheap and positive depressor of quartz or siliceous gangue were available, many impure deposits of various minerals favorably situated as regards transportation, water, or fuel, by these means may be made commercially valuable. Minerals such as gypsum, fluorspar, magnesite, and barite readily come to mind. Barite can be floated by oleic acid in the presence of sodium silicate.

The subject of flotation machines is approached with hesitation, the issue being clouded by patents, local experience, and district preference. Little can be added to Fahrenwald's statement that the most efficient machines are those that give intense aëration with finely disseminated bubbles and effective, positive circulation of the pulp, except that they must do it cheaply in installation and operation. Forrester's machine, which is gaining popularity in the Southwest, seems to fill the above-noted requirements. The newer Western mills are inclined to use Minerals Separation or Callow machines. The horizontal-drum type is favored in the Tri-State field. On some ores difficult to treat, both the mechanical and pneumatic types in series have resulted in a better recovery, and at a few places a scavenger machine is employed at the end of the rougher circuit.

Concentrating tables are being increasingly used as indicators. They make no concentrate, as their products join the circuit, but are used as a continuous vanning plaque, so the operators can constantly note changes in oils and feed.

I was formerly connected with a large research laboratory and have watched processes from the beaker up through the bucket stage; then in large laboratory operation on a three-shift basis, and, finally, small-sized commercial plants. The results obtained in a single-cell M.S. type test machine are indicative of what can be obtained in a 12-cell laboratory M.S. machine and a 2-ft. diameter by 3-ft. long tube mill—in other words, a complete miniature mill operating day after day, and no more; and changes will again have to be made upon going on a commercial basis, but valuable experience and data can be obtained. It is difficult to apply information obtained from single test cell operation to plant practice in one jump. There are a number of well-equipped commercial testing laboratories in different parts of the country, and all contemplating selective flotation work will do well to avail themselves of their services.

One company with which I am familiar has an ore carrying, among other metals, 15 per cent zinc and 15 per cent iron as pyrite, which has a decided tendency to float. Its location necessitates paying a high freight on the wet concentrate. It was found very difficult to make a flotation concentrate carrying 50 per cent zinc with a satisfactory recovery, but with a concentrate carrying 45 per cent zinc a better recovery is secured, so the problem is being solved by sintering. The feed to the

Dwight-Lloyd sintering machine carries 7 to 9 per cent sulphur and consists of one-fourth zinc concentrate carrying 30 per cent sulphur and 45 per cent zinc (when treating the above-named grade of ore), and three-quarters finished sinter of less than 2 per cent sulphur content. The water is eliminated, and the product contains 55 per cent zinc. The sulphur is replaced largely by oxygen, but there is some reduction of the zinc sulphide to the metal. When the mechanical difficulties of a plant designed for another purpose are solved, it is estimated that the cost of sintering will be under $2.50 per ton of raw concentrate. It is doubtful what the capacity will be.

Much of what is said in this article is true only in a general sense, for I know full well that many of the conclusions expressed are contrary to the experience of some operators where special conditions affect results. References given in a bibliography published in the *Engineering and Mining Journal* of Oct. 2, 1926, have been freely drawn upon and information was also obtained from an excellent pamphlet on flotation published by the Southwestern Engineering Corporation.

Black Diamonds and Their Substitutes

Frank A. Edson, in an interesting bulletin (No. 243) recently issued by the U. S. Bureau of Mines, discusses the cutting media used in diamond drilling. Black diamonds, he says, range from stones of microscopic size to those weighing several hundred carats. The largest stone ever found was irregular in outline and about the size of a baseball. The average size of black diamonds, as found, is probably 5 to 10 carats. They are bought direct from the native Brazilian miners by brokers or by representatives of the carbon houses. The black diamond is one of the rarest and most interesting of minerals; its chemical composition is exactly the same as that of the white stone, and its specific gravity ranges from 2.75 to 3.45. It is the hardest and toughest substance known. It is just as hard as the white diamond, which stands at the top of the scale of hardness, and is much less liable to fracture.

The bort, which is often used as a substitute for the black diamond, is an imperfect gem stone or white diamond. It is fully as hard as the black diamond, but is a single crystal and fractures more readily. Borts may prove a good substitute for black diamonds in oil drilling, where the formations are comparatively soft and the danger of breaking the stones is consequently much less than in hard formations. However, operators who have tried borts for coal prospecting have almost invariably found that black diamonds were more economical. It may be cheaper to use second-grade black diamonds for oil-field drilling than to use borts, which normally sell for about 60 to 80 per cent of the price of first-grade black diamonds.

A great many artificial substitutes for black diamonds have been suggested, but as yet, with one exception, none have proved satisfactory.

"Volomite" or "trimante" is the one satisfactory substitute for carbon, and it is being used rather extensively in Europe for drilling sedimentary formations. Volomite is a carbide of wolframite—a tungsten mineral that has a hardness of about 9½, as compared with 10 for the diamond. Volomite costs very much less than diamonds, but does not wear nearly as well. Dr. Th. Reinhold, director of the Netherlands Geologic Survey, Haarlem, Holland, reports that Dutch engineers have used volomite in drilling sedimentary rocks and they claim that it will drill shales, sandstones, and limestones nearly as well as black diamonds. However, as the wearing qualities are inferior, the cost of drilling with this substitute is but little cheaper than when carbon is used. The Netherlands survey recommends the use of volomite in formations where there is unusual danger of fracturing the diamonds in the bit or of losing the entire bit if the walls of the hole cave.

Stikine River Area, B. C., Canada, Awaits Prospector

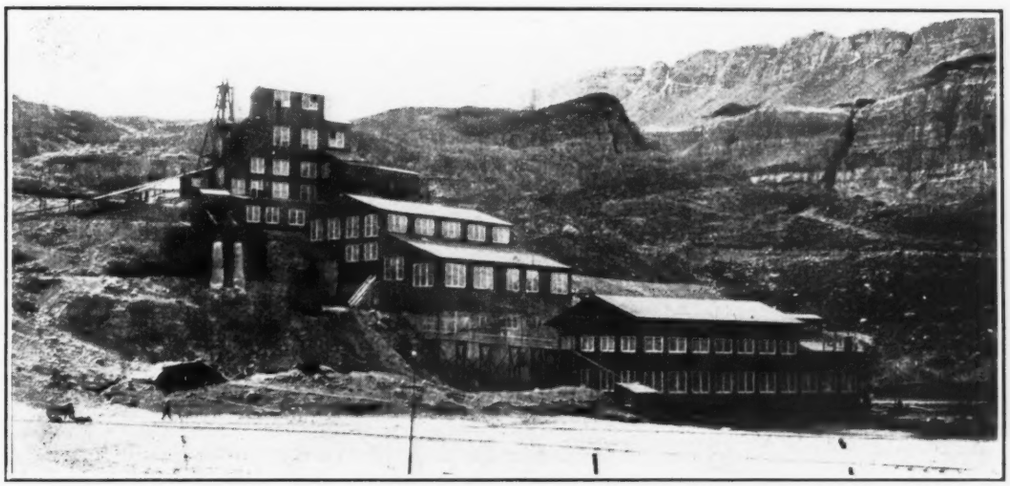
According to a recent report written by F. A. Kerr, of the Geological Survey of Canada, the Stikine River area in British Columbia possesses great possibilities as a future mining district. Mr. Kerr states that it has long been known that a fairly broad area along the eastern contact of the coast range batholith in British Columbia is geologically favorable for the occurrence of mineral deposits. This has been amply borne out by the discovery of many valuable ore deposits in areas adjacent to Portland Canal, Alice Arm, Atlin Lake, and at other points farther north and south. One of the serious obstacles to the development of the mineral resources east of the coast range has been a decided lack of economical transportation. At only a few places where the range is cut by long arms of the sea or great rivers, or traversed by railways, has it been feasible to develop mineral deposits profitably. This absence of transportation facilities, combined with the physical character of the country, has tended to discourage prospecting in areas which otherwise present considerable possibilities of reward. The Stikine River, though it has formed a highway of entry to the placer gold fields of the Cassiar for fifty-two years, has so far failed to be a means of developing that section of the zone along the contact through which it passes.

During the Cassiar and Klondike gold rushes this area was probably tested extensively for placer gold. The bars of the Stikine River itself and of the Clearwater, a tributary which, rising to the norhwest, flows along the base of the coast range, yielded some gold. Incidentally, a few lode deposits of gold, copper, and silver-lead-zinc were discovered, and developed to a small extent. These deposits support the belief that this section of the contact zone may prove as rich as others which have already demonstrated their great worth. Some prospecting of the hard rock has been done, but on the whole the area is almost untouched.

Between Portland Canal and Atlin, two of British Columbia's rich mining camps, lies a virgin territory nearly three hundred miles long and of undetermined width, which offers possibilities of producing camps like those situated at either end. This great area awaits the prospector and affords him a wonderful hunting ground, the sole disadvantage being that travel is difficult owing to the ruggedness of the country and the severity of the climate. Development should work outward from the routes of navigation, of which the Stikine River is by far the best. It crosses the margin of the coast range batholith and flows within a short distance of it for many miles, affording fair transportation facilities during five or six months of the year. The zone is also penetrated and cut by large tributary valleys.

Pumping Sixteen Thousand Gallons of Water Per Minute at Cerro de Pasco—II*

By George B. Dillingham
Superintendent Cerro de Pasco Copper Corporation,
Morococha, Peru



Morococha flotation plant

IT WAS Nov. 20 before all new parts were at the mine and the assembly started. One pump was ready to run by Nov. 30, and the second, with the short column, by Dec. 5. On Dec. 6, 1925, both pumps were started. About 22,000 gal. per minute was delivered, and this put so much water in our drainage ditch that traffic was absolutely impossible through the drainage tunnel. This temporarily held up about 200 ft. of development work per day, as all waste from development is delivered to surface by haulage through this tunnel. With only two "kick-offs" by lightning, one two-hour shutdown for the lack of cooling water when the water pipe was broken by a slough in the shaft, and a few three-minute shutdowns to clean the suctions, these pumps ran steadily, and on Dec. 17 we removed the remaining air-lift column and clamps from the shaft with the water 123 ft. down.

With four stages these pumps required only a little over 900 hp., but now with five stages the full-length pump pulled 1,280 hp. and the short one 1,250 hp. The motors are rated at only 900 hp.; and though they became hot enough to fry eggs, they did their work remarkably well. As the water lowered, the power required decreased, until only 8,500 gal. per minute was pumped by each unit, with a 250-ft. lift, and 1,200 hp. was required.

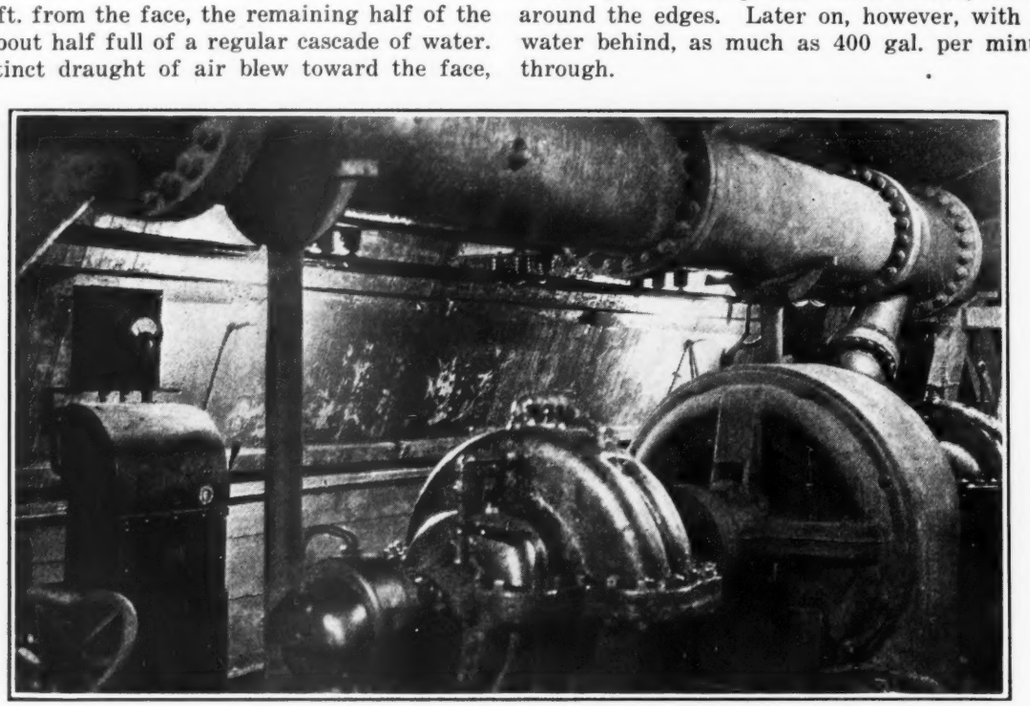
While pump No. 2 was being changed to its full length, No. 1 pump ran continuously with the exception of four eight-hour shutdowns, to allow cleaning of ditches. On Dec. 24 both pumps were again running, with the water 86 ft. below the drainage level. The water lowered steadily until Dec. 28, when one power line in the shaft blew up in a pot-head, and the water rose 21 ft. during the ten-hour shutdown required for repairing the damage. On Jan. 1, at 5 a.m., it became necessary to shut down this same pump for twelve hours while the Kingsbury bearing was changed. Only 19 ft. was lost this time, and in both cases the actual loss was only a few inches, as will be seen by the curve on page 849. The bearing that gave this trouble started to heat in the night of Dec. 31. The oil gage showed plenty of oil, but we have found that a froth frequently occurred, and only an excess of oil kept the oil level high enough for safety. Fortunately, one extra bearing was on hand. Two pairs of new bearing faces were ordered by cable, and two made up locally, but no further trouble was experienced.

By Jan. 14, 1926, the water had been lowered to 212 ft. below the drainage level, and only 3 or 4 ft. could be gained in twenty-four hours, even though the two pumps were throwing about 9,000 gal. per minute, each. The probability of this situation had been foreseen, and as the water lowered to the 600 Central station, this was cleaned up. The three motors and two smaller pumps that had been lost on this station in March were taken out. The 3,000-gal. per minute, 600-hp. pump was overhauled and another motor and compensator were installed. Two 10-in. air lifts, 330 ft. long, with 4-in. outside air lines, were placed so that they discharged into a wooden tank, which was built on the 600 station and fed the 3,000-gal. per minute centrifugal pump through a 14-in. pipe. This help at least doubled the rate of gain, and the water now lowered about 6 ft. per day.

On Jan. 20 we were able to get on to our 750 Central station, and found about 2 ft. of limonite slime wherever there was still water. The various headings were in exceptionally good condition, and the water ditch was clean. Very little water was coming from our San Miguel heading, but the Ombla heading, which had caused all the trouble, we estimated to be producing about 8,000 gal. per minute. We advanced in this head-

*The first installment of this paper was printed in the May 14 issue.

ing to within a few feet of the site of the blow, and although the drift was almost half full of waste for 200 or 300 ft. from the face, the remaining half of the drift was about half full of a regular cascade of water. A very distinct draught of air blew toward the face, bulkhead, which was finished on Jan. 30. Only 10 to 15 gal. per minute passed the bulkhead, and this came around the edges. Later on, however, with 150 ft. of water behind, as much as 400 gal. per minute leaked through.



Motor-driven centrifugal pump of 2,500-gal. per minute capacity on the 1,014 station

where it undoubtedly mixed with the water and returned. The timbermen's tools still hung on the nails, where they had left them. Near the Central shaft the water was running about 14 in. deep over the track, in spite of a ditch 4 ft. wide and 3 ft. deep.

As we previously had only about 5,000 gal. per minute from this section, we now decided that it would be much safer to cut this water off if possible. A site was therefore picked out for a concrete bulkhead about 90 ft. from the Central 750 station, and a clay dam 5-ft. thick was carried between the tunnel sets. In the ditch side of this dam four 10-in. pipes were passed to carry the water. Seven days were required to finish this dam and clean up the sides below for a concrete bulkhead. The water had risen behind the clay dam to over 6 ft. above three of the four 10-in. pipes, and almost 5 ft. above the fourth. The 10-in. pipes were 90 ft. long, in order to carry the water past the Central station. This proved that the pipes were carrying about 10,400 gal. per minute. The dam leaked 456 gal. per minute, besides what was passed by the pipes.

On Jan. 28 we started pouring about 67 yd. of concrete. As 456 gal. per minute of water was running through our forms, this was not an easy task. A mixing box was constructed just in front of the site, and materials were brought in and dumped from mine cars on to a platform. A 1:2:4 mixture was made dry and shoveled into the water. The clay dam acted as the back form, and the sides of the drift, 15 ft. wide, as sides. The dry concrete was carried as a dam in front, and the 2-in. front-form lumber was supported just below the dam by the three posts of the tunnel and ditch sets. Three 6-in. pipes were carried up with the dam and almost clear water was carried from the back of the concrete, through the dry front. No reinforcing was used, and frequent spills occasioned some waste of cement, but only six shifts were required to pour the

Thirty-six hours after the bulkhead was finished, one of the deep-well pumps developed a bad vibration, and it should have been shut down. One pump alone would not hold the water, even when aided by air lifts and the 3,000-gal. per minute pump at Central. We did not want to allow the water to rise on the 750 station, but could not close the four 10-in. valves through the bulkhead as yet.

At 2 a.m. on Feb. 3 it became necessary to shut down the deep-well pump, which had been in bad order. Just four days had elapsed since the bulkhead had been completed, but three of the valves were now closed entirely, and the fourth valve was partly closed. The water was held at the 750 Natividad level, but work which had been started on the 750 station at Natividad was abandoned for a few days, owing to the danger if the bulkhead should fail. By Feb. 8 the deep-well pump was dismantled and found to have nothing seriously wrong with it. It is now thought that, in operating, the pump bed had worked out of level. This caused a whip in the shaft and the vibration in the column. Also, one side of the upper two shaft bearings in the column became badly worn on one side. Damage was also done to the bottom motor bearing, which later caused us much trouble.

At the time that the pump stations were lost, one four-stage 500-hp. centrifugal pump was left on the 750 station. From the main concrete water-discharge column, a 24-in. pipe connected to the 750 station. At the station this was divided to two 18-in. pipes, and these were broken up into three and four 10-in. pipes, respectively. The 10-in. lines had gate valves and some check valves. The four-stage 10-in. 500-hp. pump on the station was put in operating condition. The motor was removed to surface and dried, re-wedged, and cleaned. Two old foundations were remodeled for the bases of the two 14-in. single-stage units, which were

purchased for this station. The concrete side of the sump was raised in order to make the suction lift to the pumps about 3 ft. instead of 5 ft. It would have been possible to raise this dam, as well as to make dams in two other places and give the pumps a pressure water supply, instead of a suction. Were we to do this job again, we would provide a pressure supply of water to the pumps at any cost.

By Feb. 17 the No. 2 deep-well pump was installed on the 750 Natividad pump station. The three old power cables below the drainage level had been removed, and three new ones installed. This cable weighed about 15 lb. per foot.

By Feb. 24 the No. 1, 14-in. double suction (through foot valve) 5,200 gal. per minute pump, operated with a new 500-hp. motor, and discharging directly through a 14-in. valve into an 18-in. pipe and 48-in. water column, was running. The mate, No. 2, discharged through a 14-in. T to two 10-in. check valves, followed by two 10-in. gate valves to an 18-in. pipe. This pump was propelled by a 500-hp. spare motor.

The old four-stage unit was supplied with another 500-hp. spare motor and tried out. Almost two days were lost in trying to make this pump take its load. At last we found that a 10-in. gate valve on its discharge was apparently open, but that the stem had been broken and the lip of the valve was actually shut. This lip was removed and the valve closed, leaving only a check valve ahead of the pump. This pump had previously pumped 2,900 gal. per minute to the drainage level.

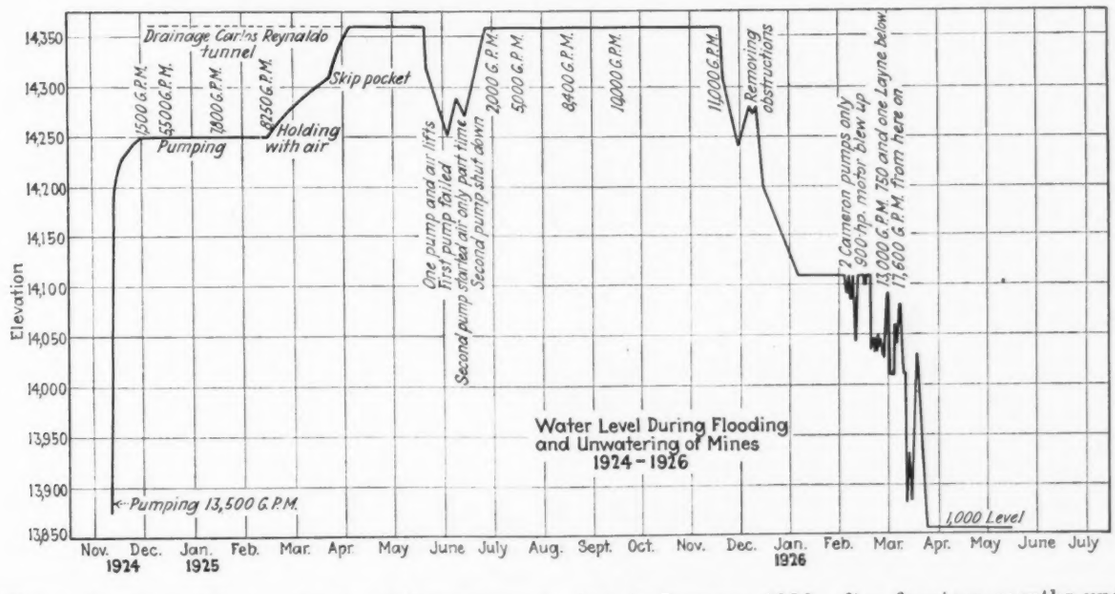
We now had a deep-well pump that would deliver about 8,500 gal. per minute from 250 ft. below the 750 level, or about what we calculated the 1,000 level to be making. We also had station pumps capable of pumping 13,300 gal. per minute from the 750 level up. No. 1 deep-well pump was still held on the drainage level to help the station pumps on the 750 in case of necessity. At this time all four 10-in. valves through the Central bulkhead were closed.

At 12:30 a.m. on Feb. 26 we started No. 2 deep-well pump on the 750 level in an effort to reach the 1,000 level. The water from this pump was discharged over a 3-ft. dam, 40 ft. from the station, and from there ran around to the pump-station sump. This dam allowed the water on the 750 level to back up in four drifts to a depth of about 3 ft., and actually made a large sump. The drainage on the 750 level came to two concrete bulkhead gates with 10-in. valves for controlling the water. The drainage from the level and leakage from the Central bulkhead amounted to about 1,500 gal. per minute. If this were not allowed to pass the gates, it naturally went to the 1,000 level and would have to be pumped from below, so an attempt was made to catch this water and pump it from the 750 pump station. By 9 p.m. the water had been lowered to 68 ft. below the 750 level. Suddenly the 900-hp. motor on the deep-well pump "blew up," and the water came back to the level in less than three hours. Examination proved that the rotor had been touching one side of the stator, and several coils had been damaged seriously. By March 3 the coils had been repaired. The rotor was found to be true, but the brass ring on the bottom of the shaft was a little worn, so it was trued up in a lathe. The bottom bearing was found to be ⅛ in. on one side, so it was rebabbitted.

Early in March we were convinced that we were short of station pumps on the 750 station. As the 600-hp. four-stage centrifugal pump on the 600 Central station was now available, we made room for it on the 750 Natividad station by using 12 by 12-in. timbers for a foundation and extending the pump end over the sump. The compensator and switchboard were placed on a platform over the sump. This addition gave us over 16,000-gal. per minute station capacity. Before this pump was running, on March 15, we found that about 94 ft. was as far as we could go below the 750 level. After it started we were able to pick up about 1,500 gal. per minute on the 750 level, and this allowed us to get down 100 ft. It was now evident that No. 1 deep-well pump must be lowered to the 750 station. This would leave us in great danger if the water should get up near the station through any circumstance and a power interruption should occur.

On March 17 we started lowering No. 1 deep-well pump from the 500 to the 750 Natividad.

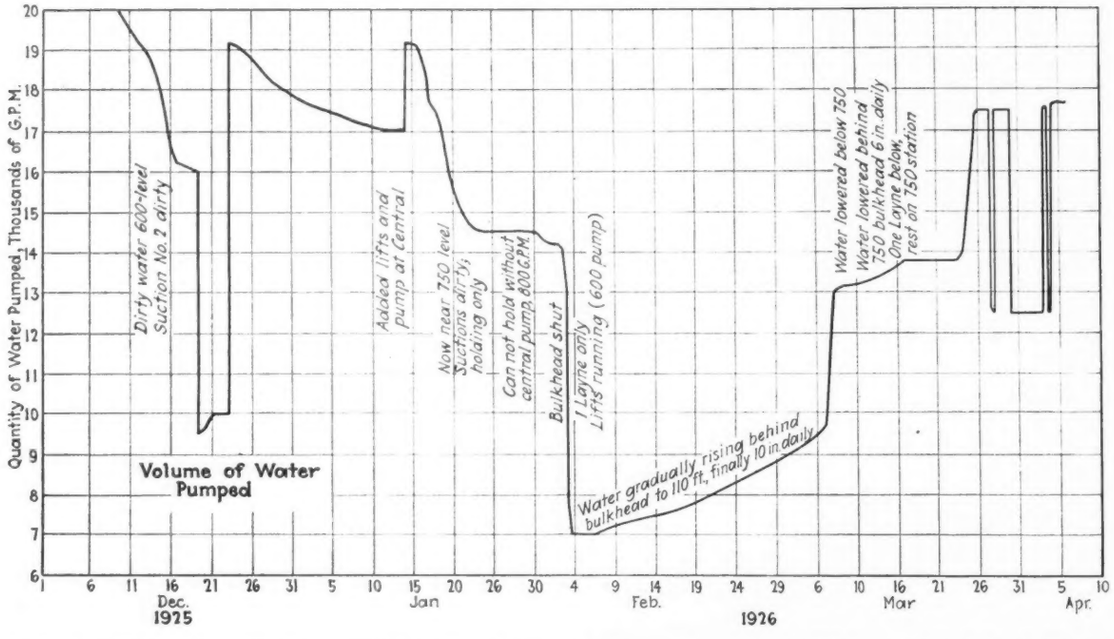
The 500-hp. pump motor which was taken to surface late in January, 1926, after fourteen months under 250 ft. of water, was cleaned and dried for about fifteen days. On examining the stator coils they were found to be in good condition. The wooden wedges had



swelled, so they were replaced. We now recommend the use of wedges that will not swell. On March 18, 1926, this motor was tried out on surface, and found to be all right.

thrust that might develop. As they were double-suction, no-thrust bearings were supplied.

The extremely gritty water wore the seal rings during the first few days' operations so severely that a thrust


Quantity of Water Pumped, Thousands of G.P.M.
Dirty water 600-level Suction No. 2 dirty
Added lifts and pump at Central
Now near 750 level Suctions dirty; holding only
Can not hold without central pump 600 G.P.M.
Bulkhead shut
1 Layne only Lifts running (600 pump)
Water gradually rising behind bulkhead to 110 ft., finally 10 in. daily
Water lowered below 750
Water lowered behind 750 bulkhead 6 in. daily
One Layne below, rest on 750 station
Volume of Water Pumped
Dec. 1925
Jan
Feb.
1926
Mar
Apr.

It was at about this time that we would have given considerable to have had a pressure feed to the station pumps instead of a suction. From the start the 14-in. pumps took so much water that they caused a whirlpool in the sump and took in air. Their capacity dropped immediately, and although this could be detected from the ammeter reading, it was not easily overcome. Before starting a station pump the weir chamber on the drainage level was clean, but after less than one hour of pumping with two 14-in. pumps, and then shutting down, at least 50 tons of sand and pyrite were found in the weir. Though less sand was pumped later, there was always some, and the immense amount pumped the first few days did tremendous damage, especially to the 14-in. pumps. No. 1 14-in. pump had no check valve in its discharge line, and the two 10-in. check valves in No. 2 14-in. pump soon became so clogged with sand that they would not close. These pumps sucked air; and it was necessary to shut them down to get the air out.

Unfortunately, the 14-in. foot valves that had been furnished with the pumps were useless; within three days after the pumps started they were broken into many pieces and were worse than no valves at all. If we had no foot valves, we could at least have had screens. Incidentally, in 1922 F. W. Collins recommended a bell-shaped suction with screens, but without foot valves, for our 10-in. station pumps on this level. So equipped they pumped about 200 gal. per minute more than with foot valves. They were primed by means of a high-pressure water eductor connected to the top of the pump cover which discharged back into the sump. Owing to our crowded station and inability to shut pumps down at this time, we were unable to get new foot valves on the 14-in. pumps until much later, when a heavy bronze ring with a divider was cast flat. The flaps were attached and a large screen was studded to the bottom. These same 14-in. pumps were equipped with a balancing chamber with $\frac{3}{4}$-in. connections on either side of the pump cover to allow for any slight was soon developed which could not be balanced. This condition was worse because the space between the impellers and seal rings was a straight, smooth opening, whereas if either the outer end of the impellers or seal rings had been upset over the outside of the other, a great deal of thrust would have been prevented. This same grit wore the glands rapidly, and air leakages gave us continual trouble. When either one of the 14-in. pumps was to be shut down, the gate valves had to be closed. This was not serious if the valves were closed before the pump was shut down, but whenever a power interruption occurred, these pumps ran backward until the gate valves were closed, and this caused serious trouble. Gate valves 4 in. in diameter work nicely with pressure on both sides, but as we now had no foot valves and were forced continually to open and close the gate valves under 250 ft. of water pressure, they became dangerous. The sleeves were screwed to the shafts, but not fastened with setscrews as they should have been, so they soon either unscrewed or stripped their threads.

At this critical time when we had one deep-well pump halfway to the 750 level and had to keep our water level down at least 100 ft. for safety, our Croya (smelter) department again helped us. Their machine shops, as well as our own, worked twenty-four-hour shifts on pump parts for repair, as well as improvement. The thrust could not be controlled on the 14-in. pumps, even after new parts were put in, and roller-bearing thrust rings between the coupling and pump ends were all that kept them going, even after thorough overhauling, until our critical situation had passed.

By March 21 two deep-well pumps were pumping to the 750 level, and an old 1,000-gal. per minute 200-hp. turbine-type station pump, as well as an old 500-gal. per minute volute station pump had been added to the 750 station. As these latter two were old, they required a great deal of attention for a few days. Loose electrical phases and hot bearings were common.

Whenever a certain station pump was not taking its water properly, as indicated by its ammeter, it would be shut down and started again. As the two 14-in. pumps had to be caught before they reversed, and as the 500-hp. motors had more than a 600-hp. load on them, and as the 600-hp. pump was equipped with a 500-hp. compensator, this was not easy. Usually when one pump was shut down to get air out, the water and air ran back into the sump, and some other pump immediately took in both, and kept the air. Power interruptions, caused by lightning, sometimes occurred several times a day, and the station was an exciting place at such times. On two or three different occasions in the next few days we were within 20 ft. of the 1,000 level, but some pump would go wrong and we would lose ground.

By adding the sums of the best that all the six station pumps had done under trial, we should have had a total of about 18,300 gal. per minute from the station up; but the weir showed about 17,600 gal. per minute when all six pumps were running. The sum of the ratings for the six motors used was 2,375 hp., but they were actually taking 2,753 hp.

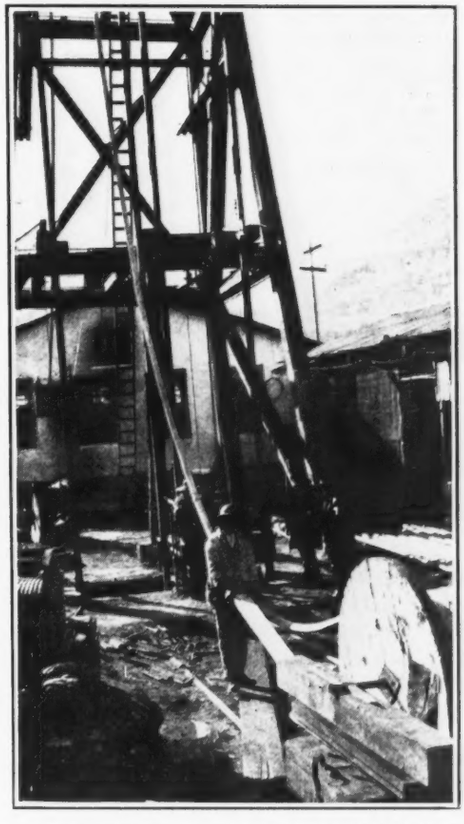
The two deep-well pumps were pumping over 16,000 gal. per minute against more than 200 ft. The power used by these pumps had now decreased until each was taking 1,225 hp. From the above it will be seen that the water pumped in relation to the actual power used was around 40 per cent for the station pumps and nearer 35 per cent for the deep-well pumps.

On April 6 at 9 a.m. Mr. Schenck and I went to the 1,000 level through San Francisco. We reached the 1,000 by a good ladderway in Vein 6, and advanced toward the Natividad shaft as far as Vein 4, where the water was too deep to advance farther. After studying the rate at which the water was lowering, for some time, we could see that a few hours more would decrease the reservoir area a great deal; also, that the rate at which the water was lowering would increase.

About 3:30 p.m. we reached the drift to Central and went up as far as the water raise. We were very much surprised to find only about 1,500 gal. per minute coming from this side. This meant that from the San Francisco side, veins 4 and 6, there was close to 16,000 gal. per minute. We advanced to the bulkhead gate, where the water was still over our boots, being about 36 in. deep and very swift. It should be remembered that water was also flowing from the valve bulkhead, but probably not so rapidly as through the manway.

More than a half hour was required with ten men to get the rails out of the gate. The water was deep and cold, and a draught was blowing from the Natividad toward the Central shaft, so that carbide lamps had to be protected to furnish light. After the rails were removed, a 3 by 12-in. timber 8-ft. long, so waterlogged that it stuck to the bottom, was taken out of the gate sump. A great many wedges and small pieces of wood could be felt in the water. The door was shut to within about 2 ft. of being closed. Then Mr. Schenck and I advanced toward the shaft. On seeing that we could reach the shaft, but that it would be impossible to close the valves with the water so deep, we decided to close the gate immediately, and then make a rush for the valves. The bulkhead gate was swung to, but evidently a wooden wedge or some dirt prevented its closing tight. Had the power gone off at this moment, as it did about twenty minutes later, the twelve of us would probably be there yet. We advanced immediately to the drift leading to the valves. The water was over our boots, but had lowered about 6 in., and we now had over a foot of space between the water and the back of the valve drift.

Only Suarez and I were familiar with the 2 by 12-in. bridge which leads to the valves, which by the way is some 18 in. lower than the 1,000 level at this point. The bottom of the drift is about 3½ ft. below the walk. By using a drill steel for a feeler we advanced toward the valve gate, and within a few minutes approached the valves. Our delight cannot be imagined when we reached the bulkhead and found that the wheels on all four valves were just out of water, and could be turned with the pressure of the finger. After closing the four valves the water lowered about a foot almost immediately. We now returned to the bulkhead gate and found that the water had risen behind the gate enough to cover it completely. On approaching the shaft the water was about 2 ft. below the level, and a great jumble of materials was found on the station. Two mine cars were end to end, and the third was on top of them. A great number of ladders, lagging, and tool boxes, and timbers of all sizes, were piled up.



Lowering "power" cables at Natividad shaft

Five of the six 500-hp. motors on the 1,014 pump station were cleaned, dried, re-wedged, and put into service. The sixth motor, however, had been badly burned at the time the station was lost, and had to be rewound. By June 3 five old standard pumps were running on the old station. On June 12 the water was again drained to the 1,000 level (except behind the 750 Central bulkhead) and the gate was opened and repaired. Apparently about 16,000 gal. per minute must be pumped now, where only 13,500 gal. per minute had to be pumped in 1924.

Discussion

Faith, Hope, and Selenium

THE EDITOR:

Sir—If you wish you may head this contribution "Faith, Hope, and Selenium," for it is a plea for all three, and is inspired by the reading of your dissertation on selenium in the May 30 issue of the *E. & M. J.*, in "Consultation," and the thought that you have not done yourself or the mining profession full justice.

You say "selenium can be used in the vulcanizing of rubber to good advantage from a technical standpoint. However, economic factors prevent its use for this purpose in a commercial way." The answer to this I will leave to others who are better qualified to differ with you, but I am quite sure that they will differ with you, for this statement is not in agreement with my understanding of the present situation.

"There are no selenium mines." Quite true, but why not a little brighter outlook, an expression of hope, and a statement of your faith in the resources of this mundane sphere and in the resourcefulness of those who direct the exploitation of its mineral wealth, and, incidentally, subscribe to *E. & M. J.*?

Once upon a time (forgive me that phrase, but most of the stories I tell now always start that way)—once upon a time there were no mines, and there were no coal or iron mines in this country, nor were there any oil wells, and once there was no cryolite mine in all the world, and once again, and not so many years ago, there were no vanadium mines. So why limit yourself to the blunt and, to my mind, hopeless statement that such mines do not exist.

There are a number of well-known selenium minerals, selenides for the most part, but they contain selenium in amounts varying from 25 to 45 per cent. Known occurrences of these minerals are, to be sure, rare, and they have generally been recognized only in connection with the search and extraction of other ores. However, is it not perfectly possible, and in fact quite probable, that mineral deposits sufficiently attractive to be worked primarily for their selenium content will some day be discovered and exploited? Personally I am of that opinion, and I would have liked to have had you say so, even though it was not entirely pertinent to the question.

Again, what is so terrifyingly impressive to you about the possibility of an additional yearly output of a million pounds of this element? Personally I would say that the chances for an annual production of 2,000,000, or even 3,000,000 lb. would be even better, for unit costs for search and research would be all the more quickly written off or reduced. Surely the quest for and the study of the possibilities of producing a million pounds a year of an element of the earth's crust is not something that the "leading periodical" of the mining and mineral industry should dismiss with a hopeless gesture and the well-defined impression that even with fantastic prices such a supply is beyond our capabilities.

"Authorities who have studied the subject" are to be sure required to carry a part of the burden of your conclusion, and while I have no knowledge of who these authorities are, it is somewhat amazing to me to realize that they, who are undoubtedly men of standing and good repute, should be so lacking in vision that they cannot see beyond the products of a dust chamber or the slime of an electrolytic refinery.

My knowledge of selenium and its occurrence may be limited, for it is comparatively recently acquired, but my knowledge of vanadium and its occurrence is, I believe, good, and I see in the history of vanadium a very possible history for selenium. "We have no way of judging the future except by the past," is as true today as it was a century and a half ago.

Vanadium was scarcely more than a chemical curiosity for the first century after its discovery, and what uses were made of it were so meagre that it too might very well have been termed a "useless element." Its mineralogy was limited; known occurrences were rare and quite decidedly non-commercial. This condition was little changed when in 1900 Arnold, of England, conclusively demonstrated its value in small quantities in steel. Did the technical press of that day immediately compute an annual demand of a million pounds and shriek—impossible? If we may judge the past by the present I imagine they did. Nevertheless, at that very moment in another continent, and naturally enough in an isolated and most forsaken spot, there lay a deposit of unprecedentedly rich vanadium ore containing what were then unknown minerals. The trail to it was along minor occurrences in asphaltite, but within a few years the discovery had been made, and, despite obstacles, Mina Ragra became the first of the world's vanadium mines. In 1906 the vanadium marketed in the United States was a bare 750 lb. Yet ten years later the domestic market was taking over 2,000,000 lb. annually, and instead of anxiety about supply the major problem was, ironically enough, how to increase the demand! And all this was accomplished without anything that might be construed as fantastic prices.

The probable fallacy of your argument for valuing this element—namely, that gold is the forty-first element and selenium the fortieth, in order of abundance in the earth's crust—is, I think, exposed by the thirty-ninth element, bismuth. Surely this element has little in common as far as value goes with gold. The modest value that it does possess is an artificial one supported solely by a controlled market, for the world's ability to produce bismuth far exceeds the consumptive demand. So, if the thirty-ninth element is relatively cheap, why should the fortieth element be dear?

Of what earthly use is the mining profession if, when industry asks for a source of supply for a certain quantity of raw material, our technical press negligently scans the past statistics of production, glibly evolves a questionable scale of value, and smilingly suggests that it is quite impossible? If the chemist, or physicist, or other investigator can demonstrate a desirable and valu-

able commercial use for any element, and particularly for an element that has so far been overlooked, or but scantily utilized, if the investigator can convince industry of the value of this use to civilization, then, by the holy shade of Agricola, let us offer them proper support. Here is a vital question, a direct challenge to the scope of modern mining, a problem that should have intense appeal to many of our profession, and the solution of which should be entirely possible if the precedents of the past are any criteria. So my plea is for a judicious mixture of faith and hope; the combination may move mountains—profitably.

Boston, Mass. WILLIAM SPENCE BLACK.

Good Prospecting Ground in Arizona

THE EDITOR:

Sir—Your articles by George L. Walker describing the copper deposits of Northern Rhodesia, and published in the *E. & M. J.* "News of the Week" under dates of March 26 and April 23, 1927, cause me to think, by reason of the similarity in everything, of a neglected and forgotten district in the south central border line of Arizona. This comprises a mineralized district about 100 miles in length by about 50 miles in width, beginning on the north with silver, lead, zinc and copper, and repeating these deposits on the southern border, but inclosing in the northern part a district about 30 miles wide by 40 miles long highly mineralized with copper, which occurs in both ledge and basin deposits.

Unlike the porphyries, some of the ore contains about 3.25 to 5 per cent copper and from 5 to 14 oz. of silver per ton, with about 50c. gold. This district lies between and includes the Baboquivare Mountains, the Sierra Blanca, the Quijotoa and the Vekol ranges. The center of the district is only about 50 miles south of the S. P. R.R. and about the same distance east of the T. C. & G. B. R.R. at Ajo.

Before and during the Civil War period parts of this district supplied some high-grade copper and silver ore, worked by "chloriders" and again following the Vekol and Quijotoa excitement it was prospected, but the larger prospecting seems to have stopped during the eighties. The recent tendency for prospectors to segregate around larger and proven camps, and when out to use an auto and avoid bad and ancient roads, also the fact that part of this district is inclosed in the Papago Indian Reservation, have materially aided in making this an unknown or lost district.

During the last winter we prospected one part of this district and, by an open cut, at a depth of 28 ft. opened up shipping ore over a width of over 70 ft.; and in an old shaft at 100 ft. depth the same ledge was exposed, with the same grade of ore over a width of more than 100 ft. Shipments of this ore, just as mined, gave a return of 4 per cent copper and 10 ounces silver.

We are not opposed to the development of the African and Canadian deposits, or of any other mineralized district under the sun. But we believe that if Arizona was prospected in a manner such as was used by the dead and forgotten prospector of the past, and a little encouragement was offered, a few large producing mines would soon be brought forward from this district, which at this time could be easily developed and if necessary held in reserve. THOMAS CHILDS.

Rowood, Ariz.

Helium Gas Wells a Source of Radium?

THE EDITOR:

Sir—The following quotations are taken from "A Text-Book of Inorganic Chemistry," by A. F. Holleman:

"The spontaneous decomposition of radioactive substances is accompanied by other phenomena . . . Rutherford discovered the cause of this phenomenon by the observation that there is a constant outflow from radioactive substances, which outflow he calls emanation. Emanation behaves in many respects as a gas. It has the properties of a gas of the argon group. Emanation must be considered as an intermediate stage in the complete disintegration of the radium atom into the above-mentioned radiations. However, other substances, part of which have not been further studied, are formed simultaneously. One of these is pretty well known—viz., helium. Ramsay and Soddy have demonstrated that helium is formed in the spontaneous decomposition of radium emanation. One gram of radium produces daily 0.499 cu.mm. helium gas."

The above matter suggests the following questions:

1. How much helium gas is produced or recovered from gas wells by the U. S. Government?
2. How much radium would be necessary to produce the above amount of helium gas?
3. Does helium gas indicate the presence of radium emanation and consequently that of radium?
4. If the third question is answered in the affirmative and the first and second show a large enough amount of radium to make it interesting, then why has no research work been done toward looking for the source of radium from which the helium is derived?

Mexico, D. F. A. B. MYERS.

[According to R. B. Moore in Liddell's "Handbook of Chemical Engineering" "the origin of helium in the air has always been ascribed to radioactive material in the earth's crust, but such an explanation is not satisfactory for the large amounts of helium present in natural gas found in certain localities in the United States. It would take immense quantities of radium, uranium, or thorium to give rise to the large volumes of helium contained in these gases, and some other explanation is necessary. It has been shown that if the velocity of the alpha particle (helium atom) in radioactive changes were to fall below a certain value, the alpha particle would not be able to ionize gases and, therefore, its presence could not be detected by ordinary analytical radioactive methods. In other words, an element might be radioactive so far as disintegration and the elimination of alpha particles is concerned without our being able to detect this fact. If this is true, it would at least explain the presence of helium in such quantities in natural gas."—The Editor.]

Russian Platinum Production

THE EDITOR:

Sir—In your esteemed publication of Jan. 22, 1927, there is an article by James M. Hill entitled "Platinum," wherein the production of platinum in the U.S.S.R. (Soviet Russia) during 1926 is given as 60,000 oz.

We herewith beg to draw your attention to the fact that during 1926 the state-trust "Uralplatina" in Russia had an output of 92,692 oz. of crude platinum. We request you to be good enough to publish this.

EDELMETALLE-VERTRIEBS AKT. GES.

Berlin, Germany.

News of the Week

Summary

THE U. S. BUREAU OF MINES will investigate the heats of formation of the common metal oxides and sulphides at the Pacific experiment station at Berkeley, Calif., for the smelting industry.

Announcement is made by the Department of Mines of Ontario, Canada, that nine geological exploration parties will be sent out during the coming season. Electrical methods of prospecting will be tried out in the Kamiskotia area.

The staff now being assembled to study geophysical prospecting for the U. S. Bureau of Mines includes Dr. C. A. Heiland, of the Colorado School of Mines, and Dr. A. Stewart Eve and Dr. David A. Keys, of McGill University.

Gold mines of the Witwatersrand established a new monthly output record in March with a total production of 860,511 oz. valued at £3,655,218.

Colorado production during February, March, and April is said to have been limited by an unusually late spring; the heaviest snowfall in years for these months was recorded.

Heap-leaching experiments involving spray treatment of ore are being made by the Pinto Valley Co. at its property 9 miles west of Miami, Ariz. It is hoped to reduce the leaching cycle to twenty days.

Legislation in the form of a diamond-control bill now being considered by the Union of South Africa Parliament creates considerable interest in London.

Federal authorities state that papers prepared by Government employees for presentation before associations and technical societies may not be copyrighted.

Samples of ore sent in from Grant's Pass, Oregon, to the U. S. Bureau of Mines are found not to contain any tin.

Ontario Announces Prospecting Program

Department of Mines to Send Nine Parties Into the Field—Electrical Method to Be Used in the Kamiskotia Area

THE Geological Exploration program planned by the Ontario Department of Mines for the coming season has just been announced by Charles McCrea, Minister of Mines. According to Mr. McCrea, the policy of the department is not at present to attempt a systematic mapping of the geology of Ontario from east to west, but rather to keep pace with the mineral discoveries crowding upon it and give prospectors and mine operators any information which can be obtained to aid them in the practical working of their properties.

E. L. Bruce, of Queen's University, with three assistants, will go into the Woman Lake gold area. Remarkably rich samples showing free gold have been taken from claims on Woman Lake, and at Narrow Lake, in the same neighborhood, there are other fine prospects. The party exploring the Lake Savant field will be headed by Dr. E. S. Moore, of the University of Toronto. Quartz veins containing gold were located on Lake Savant last year, and the sands of the shore of the lake itself have been found to contain showings of placer gold. Another party, in charge of George B. Langford, will go into the Beardmore area. Beardmore is a station on the Canadian National Railways a short distance east of Lake Nipigon, and considerable development for gold has been carried out there. M. E. Hurst will lead a party in the area northeast of Sault Ste. Marie, where in several townships promising finds of lead-zinc ore, some carrying silver, have been made. E. W. Todd and party will continue their investigations of last year in the Kirkland Lake field. North of Larder Lake, where a copper-zinc-lead ore has been discovered, T. L. Gledhill and assistants will conduct explorations. W. S. Dyer will be in charge of the Mattagami-Abitibi and James Bay party. A. G. Burrows will lead the party in the Sudbury lead-zinc-copper district. R. J. Watson and party will do the exploring in the Lake Shebandowan and Moss township area, where the old Huron mine, opened fifty years ago and afterward abandoned, is again being put into operation. On Lake Shebandowan itself there are known deposits of nickel ore, apparently carrying high values in platinum metals.

Announcement has also been made that arrangements have been completed between the department and the Hollinger Consolidated Gold Mines, Ltd., whereby the electrical survey method of prospecting will have its value indicated by a large-scale test. The government has passed an order-in-council agreeing to accept an electrical survey in lieu of a first year's assessment work upon the copper claims which the Hollinger interests have obtained in the Kamiskotia area, northwest of Timmins. This agreement stipulates that such credit will only be given, however, on condition that the indications of the survey are followed up next year by diamond drilling. Outlining the government's reason for accepting this proposal, Mr. McCrea stated he believed it to be in the public interest, and in the interest of the mining industry especially, to take advantage of the opportunity.

Lead and Zinc Discoveries in Bulgaria

The U. S. Department of Commerce reports that deposits of lead and zinc over an area of about 12,000 hectares (1 hectare equals 2.47 acres) have been discovered in the Rhodope Mountains in the southern part of Bulgaria, according to press dispatches, which claim that the lead contains 50 per cent pure metal and about 800 grams of silver to the ton, and that the zinc is in a bed more than a meter thick, near the surface of the soil. It is especially the lead which the Bulgarian government hopes to exploit, in the belief that world demand is increasing in face of decreasing supply.

The mines in the Rhodope Mountains, now owned by the Bulgarian government, have been open to exploitation only since 1925.

Several Recent Changes in Mexican Districts

Barradon and San Camilo Mines to Operate—Bolaños Mines Close—New Mill for Chontalpam

Revival of activities in the Guanacevi mining district is noted as a result of the recent announcement that the national railways of Mexico has under consideration plans for extending its branch line that runs from Durango to Tepehuanes in the mineralized region. The district may also obtain a northern transportation outlet for its ores by the construction of an extension of the Parral & Durango railroad to Guanacevi, it is stated. Hilario Lozoya and associates are getting ready to resume operation of the Barradon mine, at Guanacevi, which has a record of producing several million dollars of high-grade silver ore. This mine was shut down several years ago on account of revolutionary activities, and the workings are filled with water. Pumps are to be installed and mining will be resumed on a large scale, it is stated. In the pre-revolutionary days the Guanacevi Tunnel Co. started running a long tunnel into the mineralized mountain for the purpose of tapping the principal veins and to carry off the water. This work was stopped before the project was completed, and the company may now be reorganized and its original plans carried to fulfillment.

San Camilo mines, in the Mapimi district, State of Durango, have been taken over by the Compania Minera de San Camilo. The new company will install new machinery and carry on mining operations on a large scale, it is stated. Jose M. Chamut, of Torreon, is president of the company.

At Jalisco, the Bolaños mines have closed. A report from Guadalajara to the *Excelsior*, a Mexico City newspaper, states that the Amparo, in the district of Etzatlan, is preparing to close down also because of the low grade of ore on the lower levels, the heavy cost of keeping the mine unwatered, and also on account of constant disagreement with the labor unions.

The Southwestern Engineering Corporation, of Los Angeles, is installing the new mill at Xitinga, Guerrero, for the Chontalpam Mining Co.

Santa Inez Carretera, Pachuca, has entered into a working contract on a fifty-fifty basis with the San Carlos Co., Pachuca, for handling the ores of the Santa Inez and for development operations.

Hanna Co. Acquires Loretto Mine on the Menominee Range

The Loretto mine, on the Menominee range, Michigan, has been acquired by the M. A. Hanna Co. from the J. Ward Amberg family, of Chicago, who have worked the property for a number of years. It is planned to add to the equipment and increase output. C. H. Baxter, in charge there for many years, has been succeeded by Percy Carmichael, who was employed by the Hanna company in its operations on the Mesabi range.

Comstock Silver Mill Operating—Sonora Being Enlarged

The Comstock Silver mill, near Kingman, Ariz., is treating 80 tons of ore per day from the Banner mine of the Comstock property and from the Fountain Head mine of the Bevis Divide. This amount of ore yields 15 tons of concentrates of three classes: 1. Lead concentrates which assay 1.5 oz. gold, 50 oz. silver, and 50 per cent lead, a total value of $150 per ton; 2, zinc concentrates which have a content of .06 oz. gold per ton, 2 oz. silver, and 52 per cent zinc, a total value of $67 per ton; 3, a copper concentrate, in which the iron is carried, which runs about 6 per cent copper; this is not being marketed at present.

A report recently issued by the company shows that development work has largely increased the ore reserves. The amount of probable ore is given as 23,000 tons having a value of $35.80 per ton. There are 16,500 tons of probable ore with a value of $42.60 per ton, and 82,500 tons of possible ore with a value of $35 per ton. The total value of the ore reserves is over $4,000,000. According to report, the mill is saving 97 per cent of the values in the ore, and with a small addition to the crushing plant the production of concentrates could be doubled. The Premier crosscut is now connected with the Infallible tunnel. This connection completes an opening along the vein of 3,000 ft., all of which is ore of milling or shipping grade. It also greatly improves the ventilation throughout all the Banner workings. F. M. Manson, owner of the Kingman sampler, is manager of the property.

Four carloads of machinery have been received by the Sonora Development Co. at Congress, Ariz., for the additions being made to its concentrating plant, which is being put in condition to treat 200 tons of gold ore per day. The company owns dumps containing a million and a half tons of ore said to run $9 per ton. In mill tests which were made on the ore a recovery of 80 per cent was made. Twenty men are employed on the construction work, which should be finished in two months. The building of a 500-ton capacity cyanide plant to treat 1,000,000 tons of mill tailings, which it is reported contain recoverable values of approximately $3, is also now under consideration.

Dates Announced for First-Aid and Mine Rescue Contest

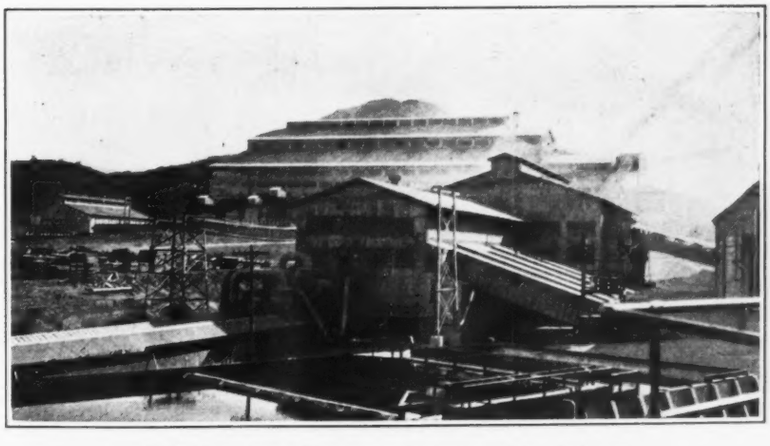
The dates for the sixth International First-Aid and Mine Rescue Contest, recently announced as to be held in Pittsburgh, Pa., have been fixed for Aug. 30 and 31 and Sept. 1. First-aid contests, in which teams from coal and metal mines, quarries, and oil-producing and oil-refining companies from numerous states will compete, will be held at Duquesne Gardens. The mine-rescue meet, which will also be participated in by teams from widely scattered mining communities, will be held on the campus of Carnegie Institute of Technology. The contest will be given under the auspices of the U. S. Bureau of Mines, in co-operation with the Pittsburgh Chamber of Commerce.

Continental Divide Using Two Shifts on Development

Two shifts a day are being employed by the Continental Divide Development Co. at Aspen, Colo., in driving a drift along the Della S. fault to cut the older contacts of the camp. From the first contact in the properties held by the corporation, it is estimated $40,000,000 has been produced without exploiting the lower contacts, which in Leadville have had a large production as well as the upper contact. Progress is averaging 10 ft. daily. About 1,000 ft. of drifting will be necessary to reach the granite, after which exploration along the contacts will be started.

Recent Production of the New Cornelia Copper Co.

Following a period of curtailment during February, when the output totaled 4,746,920 lb., the New Cornelia Copper Co. increased its production to 6,895,000 lb. in March. April production is reported to approximate that of March. The concentrator of the company at Ajo, Ariz., which is shown in the accompanying photograph, includes a concentration mill of 5,000 tons' daily capacity and a leaching plant of eleven tanks, each capable of treating 5,000 tons of ore. In the photograph a portion of the leaching plant is shown in the foreground; the flotation plant is seen in the background.



The New Cornelia concentrator at Ajo, Arizona

Current Michigan Copper District Operations

The Seneca mine is in high-grade copper ground in the 8 and 9 levels of No. 1 shaft, where crosscuts have been driven across the vein preparatory to drifting. Values in the crosscuts on both sides of the shaft are fully up to expectations. Five more drills have been put in operation in the mine. The showing north of No. 2 shaft on the 17 and 18 levels is good, with considerable shot copper in the vein. The 11 and 13 levels of No. 3 shaft, to the north, also are in good ground. Work in this part of the mine is more or less of a pioneer character, and the results to date are encouraging.

Calumet & Hecla Consolidated's No. 4 Calumet shaft is now operating, the recent fire in the shafthouse having caused little delay. Several years of mining will be required to strip this shaft of available ground. Pillars and arches remain to be removed above the 57 level, below which point the shaft was damaged by fire several years ago. Pillars left as supports in the shaft are 75 ft. thick and rich in copper values. It is estimated that fully 15 per cent of the vein rock available for mining is contained in the pillars. No pillars will be removed below the 78 level, at which point an electric hoist is being installed to carry the shaft far below the 80 level haulage level. Below the 80 level, the shaft will open a vast tonnage of virgin ground on the conglomerate bed.

Should Calumet & Hecla Consolidated develop a mine or mines in its Cliff, Phoenix, or other holdings in Keweenaw County, where extensive work will be done in the next few years, no outlay will be needed for production facilities. The Keweenaw railroad already extends to Cliff and the right-of-way beyond that point. Milling and smelting would be done at the company's plants at Torch Lake. Production would wait only on development work, and that could be speeded. With the acreage the company owns and land under option in Keweenaw, an unbroken stretch of more than 100,000 acres is available for investigation. In the Avery shaft, at Cliff, which is being unwatered, conditions are most satisfactory. The shaft, which is 1,600 ft. in depth, was sunk by hammer and drill by early day miners, whose skill in shaft construction is now being revealed. The shaft itself will require little repair and the equipment, although antiquated, has been found intact.

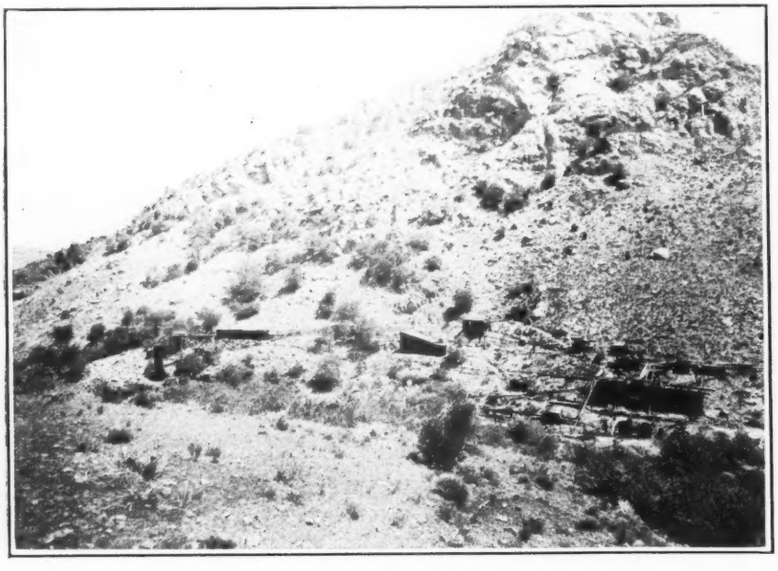
A bill introduced in the Michigan Legislature for regulation of iron-mining practice has failed of support, and there will not be any mine legislation at the present session. It was held by mining men that the exacting requirements set forth in the bill were entirely unworkable, and the legislators took this view of it.

Teck-Hughes Mills at Kirkland Lake to Treat 550 Tons

It is announced that the mills at the Teck-Hughes gold mines at Kirkland Lake, Ontario, Canada, will be treating 550 tons a day about the middle of July and it is altogether likely that before the end of the year milling will again be considerably increased. At present the first half of a 300-ton addition has just been made to the mill. This first half of the new unit is operating satisfactorily, and the old mill is treating 250 tons a day. The start of the second half of the new unit is dependent upon the completion of the shaft to the 19 level, which is the objective of the present sinking campaign. The shaft is at present near the 18 level, which is at a depth of 2,125 ft.

Ford Motor Co. Starts Drilling Near Floodwood, Mich.

The Ford Motor Co. has placed two diamond drills in operation on lands which it owns near Floodwood, in the northern part of Dickinson County, northern Michigan. Little is known of this district, except that iron formation is present, as practically no exploratory work has been conducted in the vicinity.



Scene of Pinto Valley Co.'s leaching operations nine miles west of Miami, Arizona

Pinto Valley Co. Tries Spray Leaching

The Pinto Valley Co. is conducting some interesting heap-leaching experiments at its property 9 miles west of Miami, Ariz. The purpose of these experiments is to find a method of extracting the copper from the ore which will avoid the construction of a large concentrating plant. At present the ore is being crushed to ¾-in. size and dumped in 10-ton lots into leaching tanks, where it is sprayed with a weak solution of ferric sulphate and sulphuric acid. In one lot 75 per cent of the copper was dissolved after it had been sprayed for 40 days. From another lot 44 per cent of the copper was extracted in 9 days. It is hoped to reduce the leaching cycle to 20 days.

The company is now constructing concrete floors surfaced with asphalt on which the crushed ore will be spread for spraying instead of being dumped into the tanks. A number of advantages are expected from the change of method. A larger tonnage can be handled and the cost and difficulty of handling the rock will be lowered. The crushed ore will also be more exposed to the air if spread on the floors than it would be if dumped in the tanks and will therefore become somewhat oxidized and more soluble in the acid solutions. Dissolved copper will be precipitated from the solutions electrically or upon scrap iron.

The company claims to have discovered important new leaching principles for which patent is being sought. The essential difference between the leaching method being developed at Pinto Valley and those in use at Inspiration and Ajo lies in the manner of applying the solutions. At the latter places the ore to be leached is submerged in tanks or vats of solution instead of being sprayed. If the spraying method of leaching can be perfected it might be possible to treat lower-grade ores.

New Corporation to Operate in the Tri-State District

Approximately $1,300,000 has been paid for four mines located in the Waco, Mo., zinc district, by the Missouri-Kansas Zinc Corporation. The properties involved were the Acme Lead & Zinc Co., Butte-Kansas Mining Co. and the Barnsdall Zinc Co. The Missouri-Kansas corporation was just recently organized. It has a capital of 125,000 shares of no-par value stock, and has issued $1,300,000 in 7 per cent five-year debentures. Joseph H. Schloss, of 25 Broadway, New York City, is president of the company. L. P. Buchanan, owner of the Butte-Kansas and Acme mines, received $870,000 cash for his two properties, and the Barnsdall received $110,000 cash and stock, the value of which is reported to be more than $200,000. E. Y. Ellis, of Joplin, Mo., formerly superintendent of the Butte and Acme properties, will be resident manager for the company. C. Erb Wuensch, of New York City, is consulting engineer for the company, and is in active charge of the mines. LeRoy M. Gross, vice-president of the company, had the properties involved under option the last four months.

The Situation in Sonora, Mexico

Undoubtedly the most serious menace to the mining industry in Sonora, Mexico, is the constant Yaqui Indian guerrilla warfare being waged against the government, which, though not dangerous to civilians, always presents an element of danger to those who trek into the outlying districts to look up prospects and work isolated mines. Contrary to the Yaqui custom, during the last uprising they refrained from molesting all civilians—it is generally believed through the influence of the Bishop of Sonora, who exhorted them to respect the lives and property of foreigners and non-combatant nationals.

Strange as it may seem, with this bushwhacking warfare being carried on on all sides, mines are working, and ore is being mined, milled, and shipped to smelters in the United States. Cattle ranches carry on, perhaps a little more cautiously, and business is about as usual. It is generally supposed that there are only 1,200 fighting braves left to the Yaqui tribe, whose stronghold occupies a small area of territory roughly 200 miles long by 100 miles wide centered in the Bacetete Mountains.

The San Javier district has four mines in operation. Charles E. Eagan, of Prescott, Ariz., is driving a long prospecting tunnel at the Las Bronces, 3 miles east of the village of San Javier. The tunnel will cut the lode some 200 ft. below the old workings.

The San Juan, owned by E. M. Biggs, of Denver, and which joins the Las Animas, the biggest producer in the district, is developing good commercial ore.

The Uvallama, owned by Dr. Kinney, Mr. Fenster, and T. B. Johnstone, of New York City, is producing fifty tons silver-lead chloride a day. Bullion shipments are being regularly made to New York.

Las Animas mine and mill has been running steadily under the management of E. J. Hilton. The concentrates are transported by pack mule a distance of 18 miles to Toledo.

In the Guaymas district, Los Tajos mine is being again outfitted and prepared for work. The management anticipates shipping the ore to Europe via the port of Guaymas.

Some activity is being shown in the Hermosillo district. Placeritas mine, owned in San Diego by W. G. Bowman and B. Byers, is steadily shipping high-grade silver-lead ore to El Paso. The same owners are developing a gold-silver mine near San Diego, California.

J. Campbell Besley has taken a lease and bond on the Cueva Santa mine, an antigua mine 18 miles east of Hermosillo and 3 miles from the railroad, and has begun a tunnel 200 ft. long to cut an exposed orebody of high-grade silver-lead carbonates left by the Spaniards. Some 12 miles southeast of Pesqueira station the same operator is developing a 5 ft. vein of antimony sulphide.

I. Uppercu, of New York, has taken a lease and bond on the Año Nuevo, 16 miles southeast of the capital city. Under previous management, considerable development work was done at the property. The first carload of silver-lead ore is about to be shipped.

Surface plant at the Daly-Judge adit of the Park Utah Consolidated Mines Co.

San Geronimo mine, 20 miles from Poza station, operated by E. Powell, is working steadily developing and milling ore. During the last two weeks a fine pay shoot of ore, considerably better in value than what was previously milled, was encountered.

Promising Development Work in Montana Districts

Heavier machinery is being installed to sink the shaft of the Butte Independent Mines Co. from the 60-ft. level to the 400-ft. point. The shaft, which is located on the company's Canadian group in the southwest section of Butte, at the 60 ft. point opened a 4-ft. vein of milling zinc-lead-silver ore. James LaFountain has been appointed general manager and John A. Roos consulting engineer of the company.

The St. Joseph Lead Co. has begun active development of the block "P" mines near Hughesville, Cascade County. In the southwest portion of Butte there is considerable activity. The Ardsley Butte Corporation is operating its Highland shaft; the Butte Independent Mines has started operations on its Canadian group, and two other companies expect to start operations in that district soon.

The Metals Recovery Co. has started suit against the Anaconda Copper Mining Co. seeking to enjoin the defendant from use of an alleged patent flotation process.

New Plant for Ely Calumet

The 250-hp. hydro-electric plant of the Ely Calumet Mining Co. at its Piermont mine near Ely, Nev., has been put into operation. Twelve-inch pipe has been laid two miles to convey the water to a point where there is a vertical drop of nearly 927 ft. High-pressure pipe carries the water to a Pelton wheel. Sufficient power has been developed for lighting the mine and all buildings and for carrying on all underground operations. The company has done about 3,000 ft. of drifting on its vein system.

Park Utah Consolidated Production Recovers

A curtailment of 2,600 tons occurred in the Park City, Utah, district during the last week of April, as a result of restricted shipments by the Park Utah Consolidated. The total output of the district for the week was 6,480 tons. In the following week, however, it appeared that the curtailment was only of a temporary nature, since the district output increased to 8,201 tons, and the Park Utah mines furnished 1,700 tons more than for the preceding week. It is reported that from present indications some of the smaller mines in the district may shut down because of the recession in the prices of lead and zinc, but that most of the properties will continue to operate provided prices do not go lower.

Several Nevada Properties Expand Operations

Eight feet of bedded ore has been struck in the Combined Metals mine, at Pioche, 100 ft. above the bed in which several hundred thousand tons of lead-zinc ore has been developed. The new bed, found by diamond drilling 900 ft. west of the main shaft, has been opened up for a distance of 50 ft. along its strike, and crosscut for 30 ft.; neither the lateral nor the longitudinal limits have been found. The grade of the ore is slightly better in zinc and silver values than that being stoped 100 ft. below.

Flotation machinery is being installed at the property of the Tenabo Consolidated Mining Co., situated south of Beowawe, where Utah capital under the direction of N. J. Churchill, superintendent, has opened up a good orebody above the 137 level. By reducing transportation charges to the minimum, and by making a high-grade concentrate, it is believed the Tenabo can be put on a profitable basis. J. B. Parker, formerly with the International Smelting Co., is installing the machinery.

Johannesburg Letter

By John Watson
Special Correspondent

New Monthly Gold Output Record Made by Rand—860,511 Oz. Produced in March

Johannesburg, April 12—The following results of crushings for the month of March from seventeen leading Rand gold mines have recently been published. The mines are arranged in the order of profits earned:

	Crushed Tons	Value, or Revenue £	Costs per Ton s	d	Estimated Profit £
Government Areas	205,000	391,540	15	11.7	230,393
New Modder	136,000	306,989	18	4.3	182,171
Crown Mines	221,000	298,502	19	2.7	86,108
Modder Deep	45,600	102,862	15	5.0	67,656
Springs	69,000	129,324	19	11.8	60,378
Brakpan	85,300	137,556	19	9.8	58,022
New State Areas	73,000	130,871	20	11.4	55,101
Van Ryn Deep	69,500	111,452	17	1.7	53,103
Modder B	68,500	111,181	18	0.0	49,530
Geduld	83,000	116,838	16	10.0	46,927
Sub Nigel	18,000	.....	40	9.2	36,172
West Springs	51,200	80,645	18	10.5	32,335
Randfontein	210,000	213,489	17	8.6	30,315
Langlaagte Est.	83,500	103,580	19	9.2	22,024
City Deep	90,500	133,880	24	11.1	21,083
Consolidated Main Reef	59,000	87,685	24	7.4	15,066
Robinson Deep	74,000	.....	19	1.5	14,114

The output of Transvaal gold for March was declared on April 9 by the chamber of mines as 860,511 oz., having a value of £3,655,218. This is another record monthly output and exceeds the last previous record, that of July, by 377 oz., and in value by £1,601. The native labor returns show 186,975 "boys" working on the Rand gold mines on March 31, which is an increase of 3,004 over the figure at the end of February.

Discovery of a rich new diamond area near the mouth of the Orange River is reported. This river flows into the Atlantic about 45 miles to the north of Port Nolloth, the Richtersveld lying to the South of the Orange River in a huge bend. S. Rabinowitz, who was once a partner with the late Fred C. Cornell, author of "The Glamour of Prospecting," has been in that district for twenty years. Interviewed by an *Argus* representative, on April 7, he said he had found diamonds at the Buchuberg. He acted as guide to Drs. Merensky and Reuning recently, who examined his claim and prospected further north. In seven weeks they had found diamonds which have realized over £100,000. The member for Urmagualand, J. P. Mostert, M.L.A., interrogated the minister for mines on the subject, and was assured that, as soon as the new precious stone bill has been made a law, these new diamond fields will be thrown open for pegging.

Onverwacht Platinum, Ltd., reports that 2,603 tons of ore was milled in March, yielding 682 oz. of refined platinum metals estimated to equal 5.2 dwts. per ton milled. The prospecting shaft has disclosed values averaging 4.2 dwt. from 400 ft. to 406 ft.

An extraordinary general meeting of shareholders in Government Gold Mining Areas, Ltd., is to be held in Johannesburg on May 5 to consider a resolution that the existing £1 shares be divided into four 5s. shares. The subdivision as proposed would not take effect until July 1.

On the Johannesburg stock exchange during the last week the share market has been somewhat irregular. Government Gold Mining Areas have improved from 178s. 6d. to 183s., on the strength of the probable splitting of the shares, in the next few months. New Modders have also improved by 3s. to 122s. 6d. Potgietersrust platinums have dropped 6d. to 9s. 1d.

Rich Ore Veins Discovered at Cripple Creek Mines

Osten Leasing Co., of Cripple Creek, has discovered a rich vein of gold ore in a flat vein of its Jerry Johnson mine. Portland Gold Mining Co. also discovered a rich ore vein on the 24th level of its Victor, Colo., mine. Big Banta, Rose Nicol, and Trail mines of the United Gold Mines Co. of Cripple Creek will mine over 1,500 carloads of ore the first eight months of 1927. A fairly good ore find was discovered near Summitville, Colo., although no development has taken place.

A "flivver" coming out of winter storage in the Coeur d'Alene district

Japanese Government Grants Sum for Mineral Research

The Japanese Department of Commerce and Industry has appropriated 111,000 yen for research and experimental production in connection with the working of the deposits of iron sands in northern Japan, according to advices received by the U. S. Department of Commerce. A total of 200,000 yen per year, for at least the next three years, will be granted for this purpose. For 1927, the following subsidy awards have been made: Tokiwa Shokai, 100,000 yen; Mitsubishi Seitetsu, 2,600 yen; Shichizo Mezu, 9,600 yen. The Tokiwa Shokai is now constructing reduction equipment at Kuji in the northern part of the main islands; the other two interests mentioned are investigating the problem of slag separation.

From time to time optimistic reports are made as to the results obtained. Although Japan has enormous resources of iron sands, some of which were worked in earlier periods of Japan's development, no evidence has ever been presented to show that production from these sands will enter into the commercial production of pig iron, or interfere in any way with business in iron and steel.

Within a year, it is believed in Japan, more definite conclusions can be drawn, and production costs may have been determined.

Recent Production in Colorado Limited by Late Spring

All Colorado production has been somewhat limited by a very late spring. The heaviest snowfall in years has been recorded, particularly in the mining districts, during the months of February, March, and April. The period was characterized by the installation of much new machinery, the changing hands of a great deal of property, and a fairly light production of gold and silver.

An increase in lead and zinc production has recently been noticeable at Central City and Rico, Colo. Tungsten companies have renewed operations on a larger scale. Wolfe Tongue Mining Co. and Tungsten Production Co. are doing a great deal of work in the Nederland and Caribou districts near Boulder.

Thaw of March 24 Ends Outdoor Winter Storage at Burke

At Burke, in the Coeur d'Alene district, the valley of Canyon Creek is so narrow that it barely affords room for the stream bed, the highway, and the two tracks of the Northern Pacific and the Oregon-Washington railways. Miners' homes and mine structures are forced to cling to the steep slopes. Garage space is at such a premium that many drivers leave their cars standing beside the roadway near their homes. When winter comes the snow soon buries these cars and at least protects them from theft. The accompanying photograph shows S. A. Whitehead, of Burke, digging his flivver out of winter storage. The famous "bug in a rug" was no more tightly ensconced than this bright red specimen.

Many Small Operations Current on Alaska Properties

The Peerless Consolidated Mines, Inc., is developing the Sea Level mine, a gold prospect on Thorne Arm, Revillagigado Island, Alaska. F. M. Sylvester, formerly vice-president and general manager of Granby Consolidated Mining, Smelting & Power Co., is consulting engineer, and F. Lounseberry is engineer in charge. A pilot mill and a hydroelectric plant are being installed. The property consists of 56 claims, which cover a mineralized dike over 600 ft. wide containing 19 quartz veins. The mine is an old location, having been discovered twenty-five years ago.

The Windham Bay mine is being equipped with an aërial tramway 3,000 ft. long for transportation of ore to the mill, which will operate this summer on a production rate of 50 tons a day. There is considerable activity at Fortymile, where the Cowden mine has installed a new plant. Gold-quartz discoveries of a promising character have been made on Engle Creek. On Mosquito Fork some rich gravel has been taken out. L. W. Steele is stated to have financed his holdings on Dome Creek for more extensive operation.

New York interests have arranged for extensive development of the rich copper deposits at Shushana, at the head of White River. The construction of a smelter utilizing coke is being considered.

Sunrise Mining, Hydraulic & Dredging Co. is arranging to install a hydraulic plant on Sixmile Creek, Kenai Peninsula. Considerable development will be done this summer on the base-metal deposits at Chulitna with a view to installing a mill and shipping concentrates to the Selby smelter. The Gold Cord mine, at Willow Creek, has been leased for seven years to E. H. Bartholf and G. L. Johnson.

At Innoko, the Flume Dredging Co. proposes to operate dredges this season on Yankee and Little creeks. The Berry Dredging Co. has exhausted its dredging ground at Circle, and will confine the season's work to hydraulicking Eagle and Independence creeks. Along the latter there is said to be enough pay gravel to maintain a plant for twelve years. Chandalar Gold Mining Co. is installing a mill on its quartz holdings.

Alaska Whitworth, Ltd., a British company, has completed its payments on Engineer Creek claims purchased for $100,000. The company proposes to place a dredge on the ground.

Fairbanks Exploration Co. is planning to thaw out enough ground on Goldstream and Cleary creeks at Fairbanks to provide two years' operation for the two dredges which will be delivered this fall.

Oliver Iron Furnishes Goggles with Corrective Lenses

In the Eveleth district of the Mesabi range the Oliver Iron Mining Co. has announced that all employees who have defective vision and who are required to wear goggles while at work will be furnished goggles equipped with corrective lenses.

News From Washington

By PAUL WOOTON
Special Correspondent

Bureau To Do Experimental Work for the Smelting Industry

TO COMPLY with requests from industry, more work is to be undertaken by the U. S. Bureau of Mines on the physics of the important mineral substances used in smelting. The work will be done at the Pacific experiment station at Berkeley, Calif.

For several years the Bureau has been receiving requests from the smelting industry that it undertake research work, particularly on the heats of formation and the specific heats of important compounds that enter the copper and lead furnaces. Necessary equipment for this work has been ordered, and strenuous efforts are being made to complete the other work on hand so that some time may be given to an intensive effort to secure more precise determinations of the heats of formation of the common metal oxides and sulphides. The calorimeter that will be used will incorporate all of the most approved features for precise heat measurement. It is being constructed of tantalum, which resists all mineral acids and alkali solutions. It will be of the adiabatic type and will be automatically operated by use of a photoelectric cell.

The staff which will study geophysical prospecting methods for the Bureau is being assembled rapidly. Dr. C. A. Heiland, of the Colorado School of Mines, who has the distinction of occupying the only chair of geophysics at an American school, will devote the summer to this work, as will Dr. A. Stewart Eve, director of physics at McGill University, and Dr. David A. Keys, the associate professor of physics at the same institution. Dr. Heiland will bring one of his assistants with him when he comes to Washington to begin the work.

Director Turner is anxious to place the organization and direction of this work in the hands of a technical man with broad experience in geology and mining. The name of J. E. Spurr has been suggested for that place. Mr. Turner hopes that he can be prevailed upon to undertake that portion of the work, but a final decision in this regard must await Mr. Spurr's return from Europe early in June.

Some of the associations and technical societies apparently are not aware that papers prepared by government officials for presentation at their meetings and conventions may not be copyrighted. Under the law the government employee may not copyright such a paper, and he has no authority to delegate that right to anyone else. An attempt to copyright such a paper even by one outside the government service constitutes a violation of the law, in the opinion of some of the government's legal advisers.

Tests of the bauxite which occurs in northeastern Alabama and in the district around Chattanooga, Tenn., are to be undertaken at the southern experiment station of the Bureau. Samples have been collected at various points in those districts. Tests now are being made on samples of Georgia bauxite. It has been found that samples carrying more than 20 per cent of silica present difficulties in liberating the bauxite minerals after crushing. With a lower silica content high recoveries of alumina result. It also has been found that practically all of the ore in bauxite pulp can be floated after the addition of a very small quantity of peptizer. If the peptizer is not added only about 25 per cent of the ore floats. The experiments were conducted in a fifty-gram machine.

No tin was found in the samples sent the Bureau of Mines from Grant's Pass, Ore., the scene of the recent excitement based on an alleged discovery of tin.

Cleveland-Cliffs Acquires Manganese Property

After check drilling all of last winter the Cleveland-Cliffs Iron Co. has purchased the lease and fee of the Clarke mine, located on the Cuyuna range northwest of Crosby, Minn. Also, options have been secured on the Joan No. 3 mine to the east and a forty-acre tract to the west, both adjacent to the Clarke mine. The ore in the Clarke is high in manganese, and is desired for this reason.

Humboldt Concentrator Leased

The Southwest Metals Co. states that they have leased their concentrating mill at Humboldt, Ariz., to the Phelps Dodge Corporation for a term of years.

Civil Service Metallurgical Examinations Announced

The U. S. Civil Service Commission recently announced open competitive examinations under the titles metallurgist, associate metallurgist, and assistant metallurgist. Applications for these examinations must be on file with the Commission not later than June 7. An examination is also announced for junior metallurgist, the applications for which are to be filed not later than May 28.

Full information concerning these examinations may be obtained from the U. S. Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. civil service examiners at the post office or custom house in any city.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Several Larder Lake Properties Are Overhauled for Larger Scale Operations

The Pioneer Mining Corporation reports that in the Clearwater Lake section of Red Lake, trenching to date has shown good ore across 37 ft. and for a length of about 120 ft. Considerable trenching in other directions in this area has also been done, and visible gold has been found in all trenches so far opened up. This company also holds promising lead-zinc property in the Gaspe Peninsula, from which important results may be expected in the near future. This last-named district is heavily mineralized, and underground work and diamond drilling on adjoining properties have proven that the veins persist to depth. The Pioneer was formed by the Huronian Belt interests which control the Vipond and the Keeley mines.

The Crown Reserve property, in Larder Lake, has been taken over by Leo Eranhous and associates, most of whom are Rochester people. This property was developed by the old Crown Reserve Co. to a depth of 800 ft., and shows 150,000 tons of good ore. Then the company ran out of funds, and did not succeed in making any satisfactory arrangements for further finances. The new company will be capitalized at 3,000,000 shares of $1 par, of which 1,100,000 shares will go to the old shareholders, leaving 1,900,000 shares in the treasury. An initial payment of $50,000 has been made, and it is believed that the treasury stock will be sufficient to finance the property to completion. Arrangements are being made to completely overhaul the plant and equipment. It is expected that the property will be in operation by June.

The Barry-Hollinger mine, in the Larder Lake section, is closing its mill for a few weeks to permit the installation of new machinery. Extraction in the mill has not been particularly good, as there were not sufficient tanks to give the necessary length of treatment. This defect will now be remedied, and in addition to increasing the extraction it will also increase the mill capacity. Recent developments on the 800 level have been satisfactory, and 100 ft. of good ore has been opened up.

At the Coniaurum mines, in Porcupine, the No. 12 vein has been cut on the 1,250 level. This was one of the most promising veins found on the 1,000 level; on the 1,250 level it is developing in a satisfactory way. The vein is 3 to 4 ft. wide and the grade is understood to be good.

The report of the Mining Corporation for the first three months of 1927 shows that the production in both Cobalt and South Lorrain continues to be satisfactory. About the usual tonnage of milling ore was treated in Cobalt, the average being 27.53 oz. of silver, and the total production 547,273 oz. Practically all of the mill ore has been coming from the Cobalt properties, but arrangements are now being made to ship 50 tons a day from South Lorrain. During the period there were no new developments of particular importance, but stoping operations continue to show good ore, both milling and high grade. At the Cryderman Gold property, in Manitoba, operations have been confined to diamond drilling. In Montbray Township, in Quebec, camps are erected and a systematic dip-needle and geological survey has been started. Later the properties will be prospected by electric methods. On the Flin Flon property in Manitoba the test mill has been started, but it is too early as yet to reach definite conclusions. Diamond drilling on the claims held by the company east of Cross Lake at Cobalt shows a thickness of 200 ft. of sedimentaries underlying 170 ft. of diabase. Preparations are being made to sink a three-compartment shaft to explore this ground.

It is understood that the Hollinger mines, of Porcupine, will soon start sinking the Schumacher shaft and will continue it to a depth of between 4,000 and 5,000 ft. The deepest shaft in the camp to date is the new McIntyre No. 11, which is down 4,000 ft.

New Operations and Curtailment in the Pioche District

The Combined Metals Reduction Co., operating the Amalgamated Pioche Co.'s territory under lease, is shipping a steady tonnage of lead-zinc-silver ore to its mill at Bauer, Utah. Present shipments average about 90 tons per day. The grade of the ore follows: silver, 8.0 oz.; lead, 7.6 per cent, and zinc, 17.5 per cent. The company is doing considerable exploration work with churn drills on the holdings acquired adjacent to the present leased area.

Production at the Bristol Silver mines has been curtailed. However, present development work is encouraging, and production should soon be increased. The Black Metals Co. has also curtailed operation.

The Prince and Virginia Louise mining companies are closed down. Little activity is noted on the southern side of the Pioche Range, though the Half Moon mine is again active. Promising development work is reported, and shipments from the property are expected to be made soon.

Comet district is again active after a long period of idleness. The Stella and Lyndon mines, which were recently sold to a Los Angeles syndicate, will be in charge of George E. Coxe, a mining engineer of Salt Lake City who formerly had charge of mines in the Pioche district. Three properties are operating in the Delamar district 30 miles from Caliente: the E. & H. Mining Co. is working the old Delamar mine; the Magnolia mine is being operated by Echolls & Hill, who recently shipped a 40-ton car of ore averaging $25 in gold and silver, and at the Home mine the Erisman interests, of Los Angeles, Calif., are financing the driving of a tunnel to develop the large quartz veins at depth.

London Letter

By W. A. Doman
Special Correspondent

Large Output of South African Alluvial Diamonds Seriously Affects the Industry

London, May 3—The discussion of the diamond control bill in the Union of South Africa Parliament has created more than usual interest on this side, where the bulk of the share capital of the mining companies is held and where the stones produced are marketed. Inner circles of the marketing branch of the trade are by no means happy. The very fact that they are now seeking the assistance of the government, whereas formerly they were always strongly opposed to any government interference with production, may be accepted as some indication of their position, and, it might almost be said, of the alarm with which they view the uncontrolled output of stones. It was never imagined when De Beers bought up other diamond mines in order to prevent overproduction, that such extensive deposits of alluvial stones would be discovered, and it is the continued locking up of money in keeping these properties nonproductive, and the immense sums that are utilized in maintaining the diamond market, that are beginning to make the Diamond Syndicate and its associates—among which may perhaps be included Morgan Grenfell & Co.—think seriously. It must be admitted—in fact, it is admitted—that sales of diamonds have fallen off, though figures mentioned during the debate showing a difference of 50 per cent in price were misleading, as they referred not to the average price per carat but to inferior qualities. The two men behind the diamond position are Sir Ernest Oppenheimer, who seems to have put Solly Joel in the second place, and Solly Joel himself, who, I understand, is backing the diamond trade with his own money. If he were to withdraw, then the £20,000,000 or so which his firm is reputed to be worth would be greatly missed by the other members of the syndicate, for capital locked up in useless luxuries does not please anybody. Naturally, the people on this side interested in the diamond trade are keen that the control bill should be passed, even if in a modified form.

Though the market price of tin has fallen within the past week or so to below £300 per ton, it does not greatly affect the eastern producers, for as an illustration the Tavoy Tin Dredging Corporation in its last calendar year produced 970 tons of tin oxide at a cost of £28 per ton. This compares with £36 14s. 9d. in 1925 and £40 6s. 11d. in 1924. In connection with its dredges heavy oil engines are to be installed owing to the serious loss of running time during the rains on those driven by steam. This will not only insure continuous running of the dredges by obviating loss of time resulting through the use of poor and wet fuel, but will also do away with the delays of boiler repairs and cleaning, which are serious during the low-water season.

Societies, Addresses, and Reports

World Diagnoses Economic Ills

Leaders of Forty-seven Countries Meet in Geneva to Discuss Methods of Recovery

By Edward J. Mehren
Vice-President, McGraw-Hill Publishing Company, Inc.

Geneva, May 5.—This is Thursday evening. For two days representatives of forty-seven countries have been listening to a diagnosis of the world's economic difficulties. Twelve countries have been heard from. The encouraging feature is that the diagnoses agree—surely a good basis for the discussion next week, in committee, of the details of remedies.

It is an interesting gathering. The Western world dominates in numbers, but even its composition shows variations that give the interest of wide diversity. The British and the French and the Germans are here in all their strength; but equally imposing in size of representation, by delegates and experts, are Poland, Austria, Bulgaria, Esthonia, Hungary, and Latvia, while Czechoslovakia outdoes all comers with the numerical strength of its expert group.

Then there are such other new comers in the society of nations as the Free City of Danzig and the Irish Free State. The British Empire registers strongly with its dominions and India, the Orient contributes Japan, China, and Siam; Africa sends Abyssinia, and Latin America is well represented.

Then Russia is here. That was the high excitement of the initial days of the conference; looked on as a favorable omen. Not that anyone believes in the rapid conversion of the Bolshevists from their program; but they come, they listen, they confer—that is considered progress. Their country is looked upon as a formidable element in the economic world. If confidence in her government can be developed, trade will grow on that confidence and Russia with large consuming power could be an important factor in European recovery.

America's presence, too, brings frequent and highly commendatory comment.

Such, then, is the setting. Truly a "society of nations" as tongues other than English describe the League of Nations.

The Diagnosis

What is the diagnosis on which the speakers, each speaking for his delegation, so far agree? There are, so they indicate, a number of diseases: First, that purchasing or consumptive power was curtailed by the war; second, that many trade barriers, and not merely high tariffs, have been erected, such barriers as fluctuating exchanges, high freight rates, troublesome customs formalities, quickly changed tariffs, which discourage long-time contracts, etc.

Of these diseases the restriction of purchasing power was most frequently stressed, but suggested remedies were not so readily forthcoming. Prof. Karl Gustav Cassel (Sweden), in a learned address, intimated that the restored purchasing power of backward countries might be a powerful stimulus if capital for their development was forthcoming in larger volume, and Karl F. von Siemens (Germany), again by intimation, pointed out the burdens to industry caused by the expansion of government functions and government intervention in industry. Dr. Zimmerman (Holland) also developed the same thought. Enlarged government functions withdraw men from productive enterprise and make them a tax on industry and thus on consumption. Government interference also burdens industry. The result is the reduction of purchasing power. Among government interventions Herr von Siemens cited high customs tariffs not justified by natural differences, import prohibitions, export bounties, and wage regulation. All these mislead industry into self-sufficiency, discourage technical progress, and, in sum, depress the standard of life.

As to trade barriers, the International Chamber of Commerce, represented in the discussion by Walter Runciman, has proposed a well-thought-out series of remedies which have the concurrence of its twenty-two national committees in as many countries. Chief among these is a suggestion for stabilization of tariffs—that is, that tariffs shall not change too often and without due notice. On this subject there will be more later, when the conference resolves itself into committee.

Unemployment

Naturally the question of unemployment has been very fully traversed, for it is recognized as one of the most serious results of Europe's economic dislocation. It is inevitably tied up with lack of purchasing power, and the remedy for the latter is necessarily found in the remedy for the former. But in the handling of this subject there has been a solicitude that goes beyond its consideration as a cold economic fact. The human distress is keenly felt and expressed.

Right here let there be recorded another note frequently struck in the speeches—insistence that the chief responsibility of leaders of industry and government is to improve the living conditions of the people at large. Whether this is a new note in Europe—a new note for the employer—I do not know. Certainly it does not accord with the impression we have in America of a cast-iron class distinction that refuses to recognize the ills of others. In Herr von Siemen's address this was especially striking. Again and again he came back to this as a major objective of those in responsibility, whether in government or industry.

Interdependence of Nations

One other point secured universal agreement—that nations are interdependent and that their dislocations react on each other. In fact, the conference itself is the best evidence that the interdependence is a moving thought in Europe.

Of tangible suggestions was Herr von Siemens' comment on the conditions necessary for international cartels, a subject sure to receive much discussion. He suggested that they were feasible only under three conditions: (1) that the industries in countries concerned must be accustomed to co-operate and come to an understanding; (2) that constituent national groups can be formed only where the number of those concerned is not too large, and (3) that the agreements must cover a commodity which is clearly definable and also comparable.

Dr. Zimmerman stressed the growing importance for present industrial countries of their potential home market, since backwark countries tend to establish their own industries and thus cut down their imports of manufactured goods. This means an effort to increase home consumption and therefore to raise the standard of living.

Mr. Jouhoux (France) proposed the organization of two economic bodies, one to meet at least every three years to lay out the policies for the second body, which would be a standing economic council to carry on through committees studies of important economic questions.

Finally, to an American, there was a special appeal in two points of Herr von Siemens' address: his appeal, first, for the preservation of individualism and, second, for openmindedness and flexibility in one's economic and industrial attitude. One might have been hearing an American in the forceful statement that "economic and technical progress is achieved in the first place by the industrious and untiring work of the individual and by his belief in the success of his endeavors. If individualism is eliminated from economic activities there can be no economic life." He pointed out that large-scale organizations endangered individualism and that a main concern of the manager of such an enterprise is to nurture individual effort and initiative. May not his commendation of openmindedness contain the secret of Germany's remarkable industrial progress before and since the war?

Possible Results

What will be the result of this world conference?

The question is asked and answered dozens of times each day between sessions and in hotel corridors. The answer is always the same: Do not expect too much. The problems are extremely complex. The solution must be worked out slowly. But the groundwork can be laid here. The superstructure will come at a later similar gathering. Despite the difficulty, though, some early

results are possible and may be expected.

Walter Runciman (England) put the broad fundamental well in these words: "Those who are concerned to maintain business prosperity in all countries are convinced that a mutual understanding in international economic and business problems is the surest guarantee for a growing volume of trade and for the maintenance of the higher standards of life and comfort which are the legitimate aspirations of modern democracy."

Transactions in Committees

Special Cabled Report

Geneva, May 9.—Henry M. Robinson, who is the American member of the industry committee, told the delegates that there was no excuse for America to discuss general conditions except objectively. This was in response to a question raised by Cav. di Gran Croce Alberto Pirelli, of Italy, and Sir Arthur Balfour, of England, who doubted that American methods were suited to European conditions. Both admitted that waste prevention and increased output were desirable and added that the interchange of methods and practice among industrial firms would be advantageous. The substitution of mechanical equipment for hand labor was considered not immediately possible, due to extensive unemployment. Figures on the latter were considered uncertain, inasmuch as 1923 American estimates from two sources varied three millions to five millions, with discrepancy not yet discovered.

Peyerimhoff, of the French coal mines committee, spoke eulogistically of the social harmony prevailing in America and requested information as to how this was obtained. He recognized the fact that class conflict is non-existent in America and showed an excellent understanding of American conditions. He said that Europe is seeking a cure for its ills by first obtaining financial stability.

Committees Draft Resolutions

Special Cabled Report

Geneva, May 13.—While the International Economic Conference continues to hold sessions, the various committees are engaged in the drafting of resolutions. The discussions follow the same trend as indicated in last week's cable.

In the Committee on Industry American industrial methods have been the center of discussion for two days. Delegates from England, France, and Italy have contended that our methods are not applicable to Europe, though no such protest comes from the German delegates. Despite those protests, however, it is evident that American experience has made a deep impression and is sure to be widely applied with necessary modifications.

Opinion is sharply divided on the subject of international pools. The small and backward countries fear them, though others regard them as economic saviours. The Germans apparently regard them as temporary expedients to aid in economic recovery. All agree that in their operation the consumers and workers must not be exploited. There is also a sharp disagreement on the possibilities of international control.

Henry M. Robinson, chairman of the American delegation, showed the increase of our purchases from Europe and the importance of making purchases from newly established countries. He urged the financing of undeveloped countries, which by taking equipment and machinery from Europe would restimulate European industry. The Russians are still inviting capital to their country, insisting that the Communistic régime must remain.

Meeting of Lake Superior Mining Section of Safety Council June 22 and 23

The ninth annual conference of the Lake Superior Mining Section of the National Safety Council will be held in Duluth, Minn., on June 22 and 23. Samuel F. Snively, Mayor of Duluth, will deliver an address of welcome to those attending. The program of the conference follows:

MORNING SESSION JUNE 22

Registration at Hotel Duluth, 9 to 10 am.

Opening address by Earl E. Hunner, manager of the M. A. Hanna Co., and member of the executive committee of the Duluth Safety Council.

Reading of a paper, "Physical Examinations and Accident Prevention," by Percy A. Carmichael, safety engineer of the M. A. Hanna Co. Discussion led by George Martinson, range safety inspector, Pickands, Mather & Co.

"The Necessity for Mechanical Ventilation of Mines," by W. H. Carrick, safety engineer, Corrigan, McKinney Steel Co. Discussion led by A. A. Krogdahl, mining engineer of the Oliver Iron Mining Co.

"School Safety," by A. V. Rohweder, supervisor of safety, Duluth, Missabe & Northern and Duluth & Iron Range railways. Discussion led by Joseph Wilson, assistant mine superintendent, Spruce mine, Oliver Iron Mining Co.

AFTERNOON SESSION JUNE 22

Showing of one-reel moving picture, including the new "Artificial Respiration" film of the Oliver Iron Mining Co., and "The Blue Flag" of the Pullman company, 1 to 1:30 p.m.

"Mine Lighting," by John F. Bertelling, superintendent of Palms-Anvil mines of Pickands, Mather & Co. Discussion led by P. S. Kurtzman, superintendent of Albany mine, Pickands, Mather & Co., and S. E. Quaile, superintendent of Zimmerman mine, M. A. Hanna Co.

"Safety Kinks," by A. C. Borgesen, safety engineer, Shenango Furnace Co. "A Drive Against Unsafe Practices," by H. G. Hensel, superintendent of safety, Youngstown Sheet & Tube Co. "Get-together Meetings," by L. E. Peterson, safety engineer, Oglebay-Norton Co. "Examination of Employees on Rules and Regulations," by William Connibear, safety engineer, Cleveland-Cliffs Iron Co. "Training of Shift Bosses," by L. L. Wilcox, safety engineer Oglebay-Norton Co. "First-Aid Contests," by A. H. Trastrail, range safety inspector, Pickands, Mather & Co. "Safety Inspections," by S. D. Shove, safety engineer, Oliver Iron Mining Co. "Motion Pictures in Safety Education of Workmen," by F. A. Pollock, Oliver Iron Mining Co. "Staging Platforms and Grizzlies for Cribbed Raises," by J. T. Vickers, mining captain, Pickands, Mather & Co. "Solenoid Operated Air Doors," by W. H. Carrick, safety engineer, Corrigan-McKinney Steel Co. "Carrying Case for Primers," by M. B. Orfald, safety engineer, Pickands, Mather & Co. "Safety Cartoons as an Aid to Building the Safety Spirit," by Sidney J. Sicotte, safety engineer, Pickands, Mather & Co. "Prevention of Open-Pit Accidents," by Barclay Durant, safety engineer, Oliver Iron Mining Co. "Preventing and Controlling Sand Runs on the Cuyuna Range," by Reginald Nowell, mine inspector, Crow-Wing County.

"Developing a Safety Device," by John T. Ryan, vice-president and general manager, Mine Safety Appliances Co. Mining Executives' Session—Chairman, John H. Hearding, assistant general manager, Oliver Iron Mining Co.

Banquet—6:30 p.m. Toastmaster, Francis J. Webb, manager of mines, Republic Iron & Steel Co.

MORNING SESSION JUNE 23

"Electrical Installations for Metal Mines," by D. Harrington, chief engineer, mine safety service, U. S. Bureau of Mines, Washington, D. C. Discussion led by A. C. Butterworth, chief electrical engineer, Pickands, Mather & Co.

"Blasting Kinks," by Thomas Michelle, service man, Dupont Powder Co.

Address, "Recent Work of the National Safety Council," by W. Deane Keefer, chief engineer, Industrial Section, National Safety Council, Chicago.

Address, "How to Reach the Workman," by John P. Eib, supervisor of safety and labor, Illinois Steel Co., Joliet, Ill.

The exercises will be followed by a business session.

At 1:30 p.m. sharp there will be a demonstration of new Foamite generator of Foamite-Childs Corporation by Marshall-Wells Co., local agents, at Lake Shore Park. This will be followed by a trip to the plant of the Minnesota Steel Co. at Morgan Park.

Recent Meetings of South African Societies

At a recent meeting of the Geological Society of South Africa, a paper, "The Fluorspar, Lead and Zinc Deposits in the Western Transvaal," was presented by W. Kupferburger.

At the last monthly meeting of the Chemical, Metallurgical, and Mining Society of South Africa a paper, "Notes on the Final Clean-up of a Reduction Plant," was read by J. Davidson.

The South African Association for the Advancement of Science will hold its annual meeting in Salisbury, southern Rhodesia, in June.

Recent Technical Publications

Reviews, Abstracts, and References

Benn's Mining Series

The Working of Unstratified Mineral Deposits. By George J. Young. Ernest Benn, Ltd., London, England. American Edition, McGraw-Hill Book Co., New York. Price $7.

This book is one of "Benn's Mining Series" of nine volumes to cover the field of mining. One of England's foremost mining engineers, Prof. Henry Louis, is the editor-in-chief, and the authors with the single exception of the writer of this volume are prominent English engineers.

Mr. Young's book is made to grace a library rather than a desk or reference rack. Paper of extra thickness is used, being nearly three times that of similar American books. The high quality of this paper gives a pleasing and minute clearness to the printed pages and illustrations. A thickness of 450 pages and an extra one inch in length gives the impression of a voluminous work.

The book abounds in over 200 sectional and plan drawings, perspective drawings by the author, and photographs, which are of invaluable aid to an engineer in grasping written descriptions of orebodies. The author is greatly indebted to the American Institute of Mining and Metallurgical Engineers, the *Engineering and Mining Journal*, and other sources for the abundant use of their cuts. In fact a larger portion of the material of the book is drawn from and credited to these same sources, the author through his personal visits to most of the mining districts of the United States being able to weld this scattered material published in the last few years into a well-formed, concise summary.

The first chapter deals with the different types of orebodies. Type illustrations from famous mines are given, followed by a discussion of the effect of the inclosing wall rocks on the deposit, and of the economic conditions upon the ore extraction. References are made to well-known mines and late operating costs are given. An original table on the details of large low-grade copper mines is worthy of special mention.

The second chapter deals with the application of the sciences of an engineering course to the study of rock movements and support, and it will appeal particularly to the teaching profession.

Three-fourths of the book is given to the exposition of mining methods, based upon the classification of the American Institute of Mining and Metallurgical Engineers. By emphasizing the method with a number of illustrations from operating mines all over the country, the method is made to stand out in relief.

The closing chapters deal with the latest details on mining tools, such as scrapers, auxiliary hoists, and rock drills, and on mining details such as ventilation, accident prevention and lighting.

The book brings under one cover the best of our late technical literature on the mining of unstratified deposits, and it is thoroughly indexed. It fills a distinct need for both the teaching and operating engineer.

JAY A. CARPENTER.

Principles and Practice of Mine Ventilation. By David Penman and J. S. Penman, Chas. Griffin & Co., London; J. P. Lippincott Co., Philadelphia. Price $10.

This book is given the very inclusive title of "Mine Ventilation," but it would appear that it might much more accurately be termed "A Treatise on the Ventilation of Coal Mines of Great Britain." The data contained are applicable only to a limited extent to coal mines of the United States, and the very limited amount of information given as to metal-mine ventilation does not justify its being considered as having given any appreciable contribution to that subject.

The Manganese Situation—Information Circular 6034 of the U. S. Bureau of Mines purports to show the dependence of the United States upon foreign sources for the manganese required by its industries. The twenty-one pages of the circular include numerous production tables and a study of the flow of manganese during recent years throughout the world. J. W. Furness, mining engineer, Bureau of Mines, is the author. Copies of the paper may be obtained by writing to the Bureau of Mines, Washington, D. C.

Mineral Resources—Part II, "Mineral Resources of the United States, 1923," is obtainable from the Superintendent of Documents, Washington, D. C., for $1. The author of the volume is F. J. Katz, of the U. S. Geological Survey.

Standardization—Miscellaneous Publications No. 77 of the Bureau of Standards, or "The Standards Yearbook 1927," may be obtained from the Superintendent of Documents, Washington, D. C., for $1. The volume contains much information on the present status and trend of standardization in all fields of industry, commerce, science, and government.

Illinois Geology—Bulletin No. 49, Illinois State Geological Survey, "Geology and Mineral Resources of the Dixon Quadrangle," by R. S. Knappen, 141 pp., may be secured for 50c. by addressing Dr. M. M. Leighton, Chief of the State Geological Survey, Urbana, Ill.

Utah Research Investigations—Bulletin No. 17, Utah Engineering Experiment Station, contains the following papers: "Reduction Treatment of Lead Blast Furnace Charge" and "Roasting Zinciferous Sulphide Ores." Applications for copies of the bulletin should be addressed to the Utah Engineering Experiment Station, University of Utah, Salt Lake City, Utah.

Mine Taxation—The proceedings of the tax sessions of the American Mining Congress Annual Convention at Washington, Dec. 9, 1926, have been published in pamphlet form, and a limited number are available to accountants, lawyers, and engineers engaged in taxation work, as well as the membership of the American Mining Congress, at $1 per copy.

Utah Mining Companies—A directory of Utah mining companies, giving the names of officials, underground and surface development, financial and production data, and other pertinent information, arranged by counties, is contained in Bulletin No. 4 of the Industrial Commission of Utah, State Capitol, Salt Lake City, Utah, from whom it may be obtained on request.

Metal-Mine Accidents — Technical Paper 200 of the U. S. Bureau of Mines, pp. 29, is devoted to "Accidents Due to Explosives in Metal Mines of the Southwest, as Shown by Records in Arizona." E. D. Gardner is the author. This bulletin will be of interest to all who use explosives; it is a report made in the course of the Bureau's investigation to find the safest and most economical explosive for use in metal mines and to determine the best methods of blasting under different conditions. Copies may be obtained from the Superintendent of Documents, Washington, D. C., for 5c. each.

World Mineral Data—*The Economist* (London; price 1s. 1d.) of March 26 contains an interesting statistical study of "The World's Mineral Production and Consumption" compiled by Hugh F. Marriott. Iron ore was the only mineral of outstanding importance to show a falling off in production in 1925 compared with 1913, the total decrease being 11 per cent. As regards the non-ferrous metals, if the production and consumption of 1913 be expressed as 100, the corresponding figures for 1925 are: copper, 140; lead, 130; zinc, 110; and tin, 111. The United States occupies a dominating position in the world's mineral trades, being responsible for over 60 per cent of the world's production of copper, 43 per cent of that of lead, 45½ per cent of that of zinc, and 43 per cent of that of iron ore.

Milling at Utah-Apex—*The Mining Congress Journal* for February (Washington, D. C.; price 30c.) contains a 7-page paper by Ernest Gayford on "Evolution of Milling Methods at the Utah-Apex Mine, Bingham, Utah, from 1909 to 1926." Two classes of ore are now treated by the Utah-Apex by selective flotation: lead-zinc and lead-copper. In the lead-zinc separation, thiocarbanalide dissolved in orthotoluidine has given way, as a flotation agent, to the so-called T. A. mixture (thio-ureas dissolved in analine). Experience in the flotation of lead from copper is so far rather limited.

Alabama Mineral Resources — The Geological Survey of Alabama, University, Ala., recently published Bulletin No. 28, pp. 250, an "Index to the Mineral Resources of Alabama." This is by Walter B. Jones, and is a revised edition of Bulletin No. 9. Among the subjects of more importance that are treated are bauxite, building stones, cement, clay, coal and coke, graphite, iron ore and lime, though the state has deposits of several other minerals that are of some economic importance. The bulletin will be sent on request.

People You Should Know About

S. B. McDonald, of Leadville, Colo., is visiting in San Francisco.

Philip S. Ross has been elected a director of the Asbestos Corporation, Ltd., of Montreal.

Charles E. Kehoe, mining engineer, has returned to Los Angeles from El Dorado County, Calif.

George Kingdon, general manager, United Verde Extension Mining Co., has returned to Jerome from Bolivia.

Mrs. and **Mr. W. A. Clark,** 3d, recently returned to Butte after spending their honeymoon in the Hawaiian Islands.

Harry C. Dudley has returned to Duluth from a visit to the mines of the Cusi Mexicana Mining Co. in Chihuahua, Mexico.

M. H. Sullivan, superintendent of the Bunker Hill smelter, Kellogg, Idaho, was recently in San Francisco en route from Mexico to Kellogg.

Samuel M. Soupcoff, engineer for the American Smelting & Refining Co., has returned to Salt Lake City from a month's trip to western Mexico.

G. C. Riddell has moved his offices from One Broadway to the Woolworth Building, New York. He returned in May, from three months in Central America.

J. J. Warren, president of the Consolidated Mining & Smelting Company of Canada, is visiting the mines controlled by the company on Vancouver Island.

James G. McChesney, of Toronto, has gone to the Red Lake area of northern Ontario in charge of a gang of men to open up the property of the Ontario Red Lake Syndicate.

Sydney H. Pearce, chief reduction officer at the Crown Mines, and Mrs. Pearce, left Johannesburg on April 4 for Durban, en route to England on a six months' holiday.

R. B. Lamb, mining engineer of Toronto, has left that city for southern British Columbia to examine mining properties. From there he will go to Arizona on professional business.

Charles W. Merrill left Berkeley, Calif., on May 7, to sail from New York on May 25 on his way to join his son, John, who finishes his course as a Rhodes scholar at Oxford in June.

Lancelot Smith, formerly assistant foreman of the Badger State mine of the Anaconda Copper Mining Co. in Butte, has been made superintendent of the Anselmo mine of the company.

E. G. Izod, of the Central Mining & Investment Corporation, which has an interest in many South African mining properties, with Mrs. Izod and their daughters, is making a six months' visit to England.

L. E. B. Homan, chairman of the Cam & Motor Gold Mining Co., recently arrived from England at Capetown. He is also chairman of two more Rhodesian mining companies and is on the London committee of five others.

Colonel S. H. Pollen, who is a director of the Central Mining & Investment Corporation, accompanied by a daughter, has been on a visit to Johannesburg and Rhodesia. They returned to England late in March.

J. Nelson Nevius, mining engineer, has resigned as mining valuation engineer with the U. S. Treasury Department, and has established offices as a consulting engineer at 1860 Columbia Road, Northwest, Washington, D. C.

E. R. Bruce, of Queen's University, Kingston, Ontario, will make an examination of the mineral deposits of the Narrow Brick, Clearwater and Woman Lake area of the district of Patricia for the Ontario Department of Mines.

J. A. Singmaster, general manager of the technical department, and **F. G. Breyer,** chief of research, recently resigned their positions with the New Jersey Zinc Co., and have opened a consulting office at 420 Lexington Ave., New York City.

Campbell M. Hunter, a British engineer, has returned from making an examination of a block of 14,000 acres in the Ribstone oil field of Alberta on behalf of the Ribstone-London Petroleum, Ltd., which is preparing to develop the property.

John Dunlop has resigned as manager of the Cobalt Contact mine and has been appointed manager of the Bennett Gold Mines, operating in McVittie Township, northern Ontario. **J. C. Houston** has been appointed consulting engineer of the Bennett.

Samuel Wylie Miller has donated a gold medal, to be known as the Miller Medal, to the American Welding Society, to be presented by the society annually in appreciation of work of outstanding merit in advancing the art and science of welding.

Dr. Felix F. Warliment and **Dr. Walter Schopper,** metallurgists of Hamburg, Germany, recently inspected operations of the Anaconda Copper Mining Co. and the American Smelting & Refining Co. in Montana. After leaving Montana they went to Idaho.

Harry R. Palmer, mining engineer of Los Angeles, and **J. V. McConnell,** geologist, of Long Beach, Calif., have just made extensive examinations in the southwest part of the State of Chihuahua, Mexico, and are now at Mayer, Ariz., compiling their reports.

Fenton H. Finn, of Ridgway, Pa., a junior in the department of mining and metallurgical engineering at the Carnegie Institute of Technology, has been awarded the national scholarship of $500 offered annually by the A.I.M.E. The scholarship is effective during the current college year.

D. D. Muir, Jr., manager, and **N. W. Rice,** of Boston, vice-president and in charge of western operation for the United States Smelting, Refining & Mining Co., recently made a trip from Salt Lake to Eureka, Colo., to inspect operations there at the Sunnyside mine and mill.

Dr. C. A. Heiland, head of the department of geophysics at the Colorado School of Mines, was in Washington, D. C., the last week in April, discussing geophysical problems with officials of the U. S. Bureau of Mines. Dr. Heiland also attended the sessions of the geophysical unit of the National Research Council.

T. A. Rickard delivered the commencement address at the Colorado School of Mines, Golden, Colo., on May 20, 1927. From Golden he will go to Denver and Seattle, at which last-named city he is to take part in ceremonies at the new mining building of the University of Washington on May 25, 1927.

Professor Lipovsky, an emissary of of the Soviet government at Leningrad, Russia, has been making geological explorations in South Africa, especially with regard to the platinum deposits, which he has been shown. He will soon return to Russia, taking specimens presented to him by the Geological and other societies of South Africa.

Andrew Walz has resigned as head of the engineering division of the income tax unit of the U. S. Treasury Department and has returned to private practice, his offices being at 420 Lexington Ave., New York City. Mr. Walz will spend the greater part of the summer in Canada and will probably make a trip to Africa late in the summer season.

S. R. Capps, of the Alaskan Branch of the U. S. Geological Survey, will sail from Seattle on May 28 in charge of a party which will make geologic and topographic surveys in the Mount Spurr region, Alaska. **R. H. Sargent** will sail with Mr. Capps. On the way Mr. Sargent will deliver lectures on Alaska at Denison University. **J. B. Mertie** will sail from Seattle May 24 to join **Gerald FitzGerald** in northern Alaska. Mr. Mertie's party will make geologic and topographic surveys in the region between Chandalar and Sheenjek rivers.

Carl Davis, consulting engineer and special representative of the Anglo-American Corporation of South Africa, left Queensland, Australia, at the end of March, after his visit to the Mount Isa silver-lead field in the interests of that corporation. He was accompanied to Mount Isa by **W. H. Corbould,** managing director of Mount Isa Mines, Ltd., and **Frank L. Bosqui,** chief metallurgist on the staff of the Anglo-American Corporation. **H. A. Titcomb** and **R. M. Geppert,** mining engineers, who preceded Mr. Davis to Mount Isa to make preliminary examinations of the mines, remained there for a short time after Mr. Davis left.

Richard Hamilton, a prominent figure in mining concerns in Australia, has resigned as general manager of the Great Boulder Proprietary Gold Mining Co., Kalgoorlie, Western Australia, a position which he held for over thirty years. Mr. Hamilton has controlled this big mining corporation practically since its inception. During his term the Great Boulder produced gold to the value of about £14,000,000 and has paid £6,000,000 in dividends. He has been president of the Kalgoorlie Chamber of Mines for a number of years, and has been the leading personality in Western Australian mining circles for about a quarter of a century. Mr. Hamilton has now accepted the position of local director and attorney for the Great Boulder company.

An Appreciation of Otto Rissman

Otto Rissman, general manager of the National Zinc Co., died on May 1, 1927, at his home in Kansas City. A quiet, unassuming man, who never sought to draw attention to himself, he was in fact one of our most distinguished zinc metallurgists.

Rissman was ever rather reticent in respect of himself, even with his best friends, and he let us know but little of his ancestry and early life. He was born in Brandenburg, Prussia, about fifty-eight years ago. His father was a superior officer in the old army. At about the age of eighteen Otto came to America; under just what circumstances or how he completed his education and first became occupied we do not know. We first heard of him as an assistant to Prof. W. B. Potter, in Washington University, St. Louis. He had during this early period acquired chemical and metallurgical knowledge and experience.

Soon after the Cherokee-Lanyon Spelter Co., consolidating many of the small zinc smelting concerns of Kansas, was organized in 1897, Rissman became its chemist. At that time zinc smelters were just beginning to have chemists. Not yet were they even thinking of metallurgists. The initial functions of the zinc smelter's chemist were hardly more than to assay the ores under treatment.

I first met Rissman in 1899 when I was studying the affairs of the Cherokee-Lanyon Spelter Co. in behalf of clients who were proposing to take them over. A. B. Cockerill, the general manager of the company, assigned Rissman to aid me in my technical investigations, and so we worked together intimately for a while and had many discussions and co-operations. I wanted to analyze the Western zinc smelting practice of the time, which was indeed of prime importance in view of the new use of natural gas at Iola and Cherryvale, which seemed to me to be threatening the existence of the smelters using coal at Pittsburgh and vicinity, although Mr. Cockerill, who subsequently became my esteemed friend, did not think so.

I interested Rissman in helping me to work out a metallurgical balance sheet for the Belgian furnace employed at Pittsburgh. My recollection is that our first survey resulted in an apparent zinc extraction of 106 per cent, which proved to us that this kind of weighing and measuring was not the simplest thing in the world. Following our work of this summer Rissman and myself were ever afterwards friends. Although our meetings were infrequent our correspondence was constant.

Within a few years the Cherokee-Lanyon Spelter Co. was constrained to abandon its coal smelters as I had foreseen, but continued to operate a gas smelter at Iola, Rissman remaining with the company. In 1906 he left it in order to become general manager of the National Zinc Co., and he built its plant at Bartlesville, introducing into it numerous intelligent innovations, departing from the prevailing spirit of stodgy imitation in the Kansas-Oklahoma smelting field. Rissman continued with the National Zinc Co. during the remainder of his life.

I should become unduly technical if I should go far in reviewing the many things that he did in the Bartlesville, Argentine, and Springfield plants of his company. He was imaginative and bold, ever ready to try new ideas that seemed to him to be logical. They did not always prove successful, but they were ever well considered and worth trying. Thus he worked with the Saeger charging machine and himself invented a retort cleaning apparatus. He improved the old Zellweger roasting furnace, creating the Rissman-Ruebel as an intelligent modification of it. When the Spirlet furnace was introduced at three smelters in this country Rissman and his staff was the only one to make it work satisfactorily, they developing in fact an American-Spirlet, just as the Australians stuck to their problem and developed the Barrier-Spirlet. In recent years Rissman had absolutely led the way in introducing into American zinc smelting practice the process of double-roasting, employing the Dwight-Lloyd sinterer, wherein the industry is just getting ready to follow him.

Otto Rissman

His was one of the best brains in our industry and he was blessed with a confidence in himself and a boldness of spirit that combined to make him a leader. Yet not even would those important qualities have been enough. There was required also his great knowledge of human nature and his own unique personality. The industrial leader must be able to persuade many other persons to follow him; on the one hand boards of directors; on the other hand plant personnel. Rissman was a philosopher and had moreover a gift of expressing himself in ways that the financier and the furnace charger could both understand. He was a composer of aphorisms, into which he introduced both humor and a keen economic sense. This was one of his ways as an instructor, and in it he was often amusing and always enviable.

It is a source of satisfaction to me that only a fortnight before his death Rissman was in New York and he and I foregathered in two long sessions discussing problems of zinc metallurgy, looking into the future. I was more than ever impressed by his vision and determination. When we parted he reproached me with my failure to keep an old promise to visit his Bartlesville plant along with him. Alas! that now that may not be. W. R. INGALLS.

Obituary

Carl P. Carlson, general foreman of the reverberatory plant of the Nevada Consolidated Copper Co. for the last twenty years, died recently at Ely, Nev., after an illness of several months. Mr. Carlson, a native of the Swedish isles in the North Sea, was born in 1857 and came to America as a young man, and engaged in mining at Butte. He was connected with the Nevada Consolidated Copper enterprise since its beginning.

Fred E. Carroll, of Ouray, Colo., for many years manager of the Atlas mine, one of the largest in Ouray County, died at his home in Fruita, Colo., last week. Mr. Carroll was State Commissioner of Mines in Colorado in 1915. He had been vice-president and general manager of the Atlas Mining & Milling Co. since 1919. He had for years been active in industrial and political associations, and was a member, also, of the War Minerals Commission, the A.I.M.E., and of the Committee of Fifteen of the Silver Producers' Association. Mr. Carroll was prominent in the councils of the Republican Party in Colorado, and in civic and municipal affairs as well.

Ira H. Woolson, for seventeen years consulting engineer for the committee on construction of buildings of the National Board of Fire Underwriters, died recently in Chicago. Mr. Woolson was born on Aug. 11, 1856, in Niagara County, N. Y., was graduated from Columbia School of Mines in 1885 with the degree of E.M., served two years in the New Jersey Geological Survey, and in 1887 returned to Columbia School of Mines as assistant instructor in drawing. In 1891 he became the university's testing engineer for fireproof materials and founded that institution's laboratories. He continued in that work for nearly twenty-three years.

Clarence Morton Boss, mining engineer and inspector of mines for the Oliver Iron Mining Co., died May 11 at his home in Duluth, Minn. He was seventy-seven years old. Mr. Boss started his engineering career in 1870—the year that he was graduated from the University of Michigan—on the Marquette iron range. His first work was with the State Geological Survey. Later he went into general engineering practice. He installed one of the first compressor plants, at the Republic mine, in 1876. In 1886 he went to the Gogebic range, where he served as inspector of mines for Gogebic County, and he was the first mayor of Bessemer. In 1896 he went to the Mesabi range as superintendent for the Franklin Mining Co. Later he engaged in mining work in Canada, returning to Duluth in 1906 to enter the employ of the Oliver company. He was a charter member of the Lake Superior Mining Institute.

Market and Financial News

Coeur d'Alene Mines Earned Less on Bigger Production in 1926

MINES of the Coeur d'Alene district, Idaho, in 1926 earned net profits aggregating $7,957,901. Compared with the net profits in 1925, this is a decrease of $833,858. This decrease is due to the lower average prices of lead, silver and zinc in 1926 as compared with 1925. The small difference in gross value of product indicates that the actual ore tonnage produced in 1926 was greater than in 1925. The figures in the accompanying table are taken from sworn statements filed by the profit-earning mining companies of the district as required by the law of Idaho.

Several other mining companies, notably the Sullivan (Bunker Hill-Hecla), Page (Federal), Galena (Callahan Zinc-Lead), and Jack Waite Leasing, do not appear in the list. All of them made large outlays for development, mill construction, and complementary operations, expenditures which were far in excess of income. The list of profit earners include six which were not in the list for 1925—namely; Sunshine, Sidney Leasing, Sidney Mining, Hypotheek, and Douglas. Profits for this year will probably be considerably less than last year, on account of the continued decline in the prices of metals. This condition so far this year has not affected production, which continues at the maximum, with no intimation that curtailment is contemplated.

Coeur d'Alene Mine Profits in 1926

Mining Company	Gross Value	Net Profit
Federal M. & S. (Morning)	$8,018,027	$2,543,605
Federal (Wyoming)	15,054	1,128
Federal (Frisco)	173,955	18,134
Bunker Hill & Sullivan	7,202,042	2,527,116
Bunker Hill (Crescent)	208,305	110,393
Hecla	5,479,367	2,459,927
Gold Hunter	571,542	56,614
Caledonia	48,066	4,913
Sunshine	257,793	65,569
Sheridan Lease	387,086	15,042
Strattons	178,926	62,338
Tamarack & Custer	1,198,332	27,000
Sidney Leasing	157,336	8,805
Sidney Mining	16,884	14,277
Hypotheek	157,139	34,942
Douglas	10,304	8,091
Total	$24,080,167	$7,957,901

Zinc Export Association Files Papers With Trade Commission

The Zinc Export Association, Inc., 61 Broadway, New York City, has filed papers under the Export Trade Act (Webb-Pomerene law) with the Federal Trade Commission, for the purpose of exporting metallic zinc in slabs. Officers of the association are: A. J. McKay, president; B. W. Zimmer, Charles T. Orr, and A. E. Bendelari, vice-presidents; W. A. Ogg, treasurer; C. H. Klaustermeyer, secretary; and Ernest V. Gent, assistant secretary and assistant treasurer. Members are: The American Metal Co., Ltd., New York City; Athletic Mining & Smelting Co., Joplin, Mo.; American Zinc, Lead & Smelting Co., Boston, Mass.; Illinois Zinc Co., Chicago, Ill.; The Hegeler Zinc Co., Danville, Ill.; Matthiessen & Hegeler Zinc Co., La Salle, Ill.; The Grasselli Chemical Co., Cleveland, Ohio; Quinton Spelter Co., Joplin, Mo.; United Zinc Smelting Corporation, New York City; Fort Smith Spelter Co., Greencastle, Ind.; and Eagle-Picher Lead Co., Chicago, Ill.

The Export Trade Act grants exemption from the anti-trust laws to an association entered into and solely engaged in export trade, with the provision that there be no restraint of trade within the United States, or restraint of the export trade of any domestic competitor, and with the further prohibition of any agreement, understanding, conspiracy, or act which shall enhance or depress prices or substantially lessen competition within the United States or otherwise restrain trade therein.

Go'd Production from mines in northern Ontario for the first quarter of 1927 was valued at $7,701,762, compared with $7,609,642 in the same quarter of 1926. The average grade of the ores is declining as indicated by the comparative tonnage figures: 1,009,681 in 1927 and 855,516 in 1926. Porcupine gold production declined 3.5 per cent; in Kirkland Lake it increased, according to the report, 19.3 per cent.

Lucky Tiger-Combination Gold Mining Co. reports an operating profit of $713,955 for 1926. The ore produced amounted to 78,807 tons having a gross value of $2,203,778. Taxes and miscellaneous expenses were $94,253, leaving a net income of $621,422. Operating costs of production and marketing are given in the table below.

	Per Ounce Silver in Concentrate	
Year	1925	1926
Development	$0.056	$0.070
Mining	.125	.138
Milling	.066	.066
Marketing	.250	.241
General	.032	.030
Income tax	.023	.020
Total	$0.552	$0.565
Credit for gold, copper and lead	.200	.219
Net cost	$0.352	$0.346

Mother Lode Coalition Mines Co. reports for the year ended Dec. 31, 1926, profit of $1,968,099 after expenses and taxes but before depreciation and depletion. In 1925 profit was $2,104,394 on the same basis, and after providing $2,318,208 for depreciation and depletion, there remained a deficit totaling $213,814.

Statistical Notes

Platinum and Palladium statistics compiled by the U. S. Bureau of Mines show stocks of these metals in the hands of refiners on various dates as follows:

End of Year	Platinum, Ounces	Palladium Ounces
1918	51,504	10,086
1919	29,228	10,235
1920	46,747	16,565
1921	38,514	21,042
1922	41,900	24,975
1923	36,554	26,266
1924	40,464	27,400
1925	44,024	26,740
1926	64,203	31,950

Utah Copper Co. for the quarter ended March 31, 1927, reports net income of $3,692,354 after taxes and depreciation, but before depletion, compared with $4,696,913 in the preceding quarter and $3,129,857 in the first quarter of 1926. In the first quarter of 1927 the company produced 61,752,783 lb. of copper, a monthly average of 20,584,261 lb. This compares with a monthly average of 21,105,489 lb. in the last quarter of 1926 showing a decline in the rate of output.

Calumet & Hecla Consolidated Copper Co. during the quarter ended March 31 realized a net profit of $153,623 after depletion and depreciation on a gross income of $3,632,230. These figures compare with $54,322 and $3,598,443 for the corresponding quarter of 1926.

Dome Mines, Ltd., in the first quarter of 1927 milled 127,300 tons of ore, with a recovery of $7,633 per ton. Production totaled $971,665, and after deducting operating and general costs and taxes of $4.191 per ton, and crediting miscellaneous items, income was $484,819. No allowance for depletion and depreciation is made in the calculation of this figure.

New Jersey Zinc Co. reports the following financial results of its operation during the first quarter of 1927:

Receipts	
Income, after deducting for expenses, taxes, maintenance, repairs, depreciation, depletion and contingencies	$1,169,480
Add	
Dividend from the Tulsa Fuel & Manufacturing Co.	600,000
Total income	$1,769,480
Deduct	
Dividend 2 per cent payable May 10, 1927	981,632
Surplus for the quarter	$787,848

Rhodesian Copper development and exploration companies are having little trouble raising funds. By recent issues of shares Southern Rhodesia Base Metals raised $1,500,000, Rhodesian Congo Border Concession $1,000,000, and Bwana M'Kubwa $700,000, the shares being sold at premiums over par of 300, 200 and 40 per cent, respectively.

International Nickel Co. for the quarter ended March 31, 1927, reports net profit of $1,407,707 after depreciation, depletion and federal taxes. This compares with $1,366,573 in first quarter of 1926.

Alaska Juneau Gold Mining Co. reports April gross earnings of $163,000, compared with $139,200 in April, 1926. The deficit after taxes, interest, and expenses was $40,000, against deficit of $33,800 in the same period of 1926.

Freeport Texas Co. reports for quarter ended Feb. 28, 1927, net income of $718,852 after expenses and reserves for depreciation and taxes. This compares with $267,824 in the corresponding quarter of 1926. Gross sales were $2,785,801 against a total of $1,972,926 a year ago.

Phosphate Rock sold by producers in the United States in 1926 totaled 3,209,976 long tons, valued at 10,893,800, according to figures compiled by the U. S. Bureau of Mines. The figures indicate a decrease of 8 per cent in quantity and of 6 per cent in value as compared with 1925. Quality and value, of the various kinds of phosphate rock mined in the United States and sold in 1926 were as indicated in the following table:

	Long Tons	Value
Florida		
Hard rock	116,264	$465,308
Land pebble	2,591,943	8,218,200
	2,708,207	8,683,508
Idaho		
Western rock	33,113	133,020
Tennessee and Kentucky		
Blue and brown rock	464,192	2,048,272
Wyoming		
Western rock	4,464	29,000

Imports of phosphate rock in 1926 were 17,378 long tons, valued at $192,611, or more than six times as great in quantity and five times as great in value as those of 1925. Exports amounted to 749,163 long tons, valued at $4,440,074, a decrease of 14 per cent in quantity and 22 per cent in value compared with 1925.

North Star Mines Co. reports production during 1926 as valued at $743,047.94 with outlays for current operation totaling $714,662. Development cost was $414,834, of which $137,170 was charged to the expenses of the year and the balance, $277,664, was added to the amount ($262,015) already charged for advance development, making a total of $539,678 carried in suspense. Operation and development for 1926 totaled $851,832, exceeding production by $108,784; other sources of income brought in $83,769, and after allowing $16,655 for plant depreciation, the net deficit to the balance sheet for the year reached $41,625.

Park-Utah Consolidated Mines Co., for the first quarter of 1927, including the income derived from the Ontario mine controlled by the company, earned $500,000 after deduction of taxes but before depreciation. Current production is said to be at the annual rate of 5,500,000 oz. of silver, more than 50,000,000 lb. of lead, 43,000,000 lb. of recoverable zinc, and 18,000 oz. of gold.

Manganese Production in Brazil declined during the first two months of the current year. January output totaled 18,203 long tons, compared with 33,665 long tons in the same month of 1926. February's production figure was 16,757 long tons, against 24,035 tons in February 1926. Brazilian exports of manganese ore in January amounted to 21,783 long tons, against 26,500 tons in January, 1926. Exports in February totaled only 6,000 long tons, compared with 40,700 tons in the same month of last year. This reflects dull demand in the manganese market in the United States.

Potash Sales of the German Potash Syndicate during the first quarter of 1927 totaled 538,124 metric tons, against 419,590 metric tons sold in the first quarter of 1926, according to advices to the U. S. Department of Commerce from Berlin.

American Metal Co. reports for quarter ended March 31, net income of $586,075 after federal taxes, depreciation, and reserves. This compares with $702,668 in the first quarter of 1926.

Mount Lyell Mining & Railway Co. reports for the year ended Sept. 30, 1926, total ore mined from North Mount Lyell mine, 188,303 tons, of which 2,264 tons was high-grade and 116,039 concentrating ore, the average assay of the whole being 6.04 per cent copper, 1.06 oz. silver, and 0.019 oz. gold per ton. Ore reserves in the North Mount Lyell mine are estimated at 898,123 tons of 6 per cent copper ore. At the reduction works a total of 44,983 tons of ore and concentrates yielded 6,925 tons of blister copper, the metal yield being 6,860 tons of copper, 133,338 oz. of fine silver, and 2,211 oz. of fine gold.

Tongkah Harbour Tin Dredging Co., Puket, Siam, reports for the year ended Sept. 30, 1926, a total of 2,679,600 cu.yd dredged. Tin oxide produced, totaled 552 tons. The average yield was 0.462 lb. per cubic yard. Value of the tin output exclusive of royalty was £89,388. Dredging costs totaled £57,980, or 5.192d. per cubic yard. Other charges were £19,626, or 1.757d. per cubic yard, and operating suplus was £11,781. Four dredges were operated during the year.

The Metal and Ore Corporation, Woolworth Building, New York City, has been appointed agents in the United States for LeMoine-Bies et Harang, Paris, France, large European factors as buyers of zinc, lead, antimony and other non-ferrous ores.

Every State in Union Is Producer of Minerals

Coal State Leads, Followed by Oil—Arizona, First Copper State, in Eleventh Place

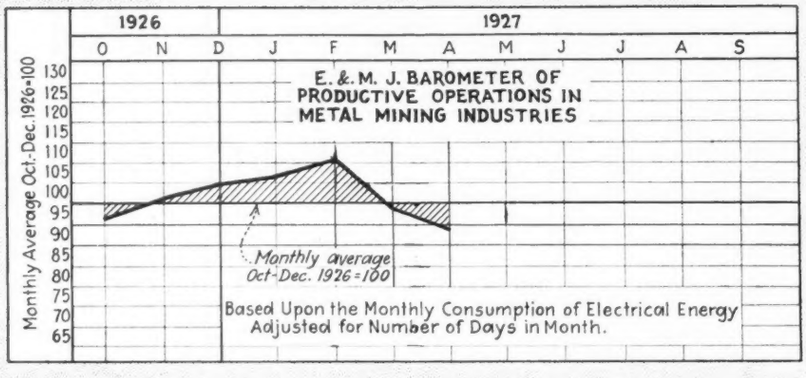
The importance of the mining and mineral industries of the United States is emphasized by the accompanying table, showing the estimated value of minerals produced in each of the states during 1925. The non-ferrous metals necessarily are eclipsed by coal and petroleum, but Arizona, the leading copper state, stands ahead of Minnesota, the ranking state in iron-ore production. Among the important mineral products, the table reveals, are cement and clay products. In general the valuation is based on the worth of the product at the place where it is taken from the ground.

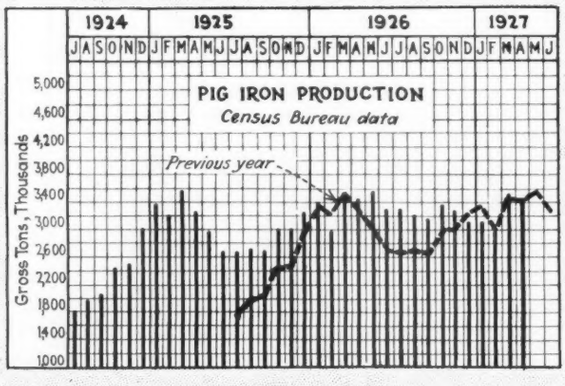
Principal Mineral Products of the United States in Order of Importance

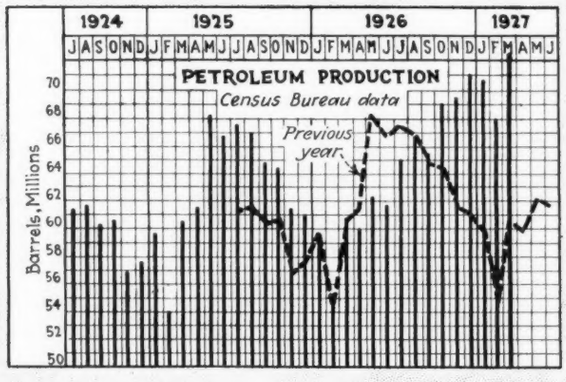
State		Value
Pennsylvania	Coal, cement, clay products, natural gas	$867,196,000
Oklahoma	Petroleum, zinc, natural gas	501,767,000
California	Petroleum, natural gas, cement	496,923,000
Texas	Petroleum, natural gas, sulphur	351,212,000
West Virginia	Coal, natural gas, petroleum, clay products	333,528,000
Ohio	Clay products, coal, natural gas, petroleum	247,507,000
Illinois	Coal, clay products, petroleum, cement	231,680,000
Kansas	Petroleum, zinc, coal, cement	142,944,000
Kentucky	Coal, petroleum, clay products, natural gas	131,371,000
Michigan	Iron ore, copper, cement, salt	122,212,000
Arizona	Copper, silver, gold, lead	114,203,000
Indiana	Coal, cement, stone, clay products	111,834,000
Minnesota	Iron ore, stone, cement, clay products	110,253,000
New York	Clay products, gypsum, cement, stone	102,036,000
Utah	Copper, lead, silver, coal	100,275,000
Missouri	Lead, clay products, cement, coal	92,548,000
Arkansas	Petroleum, natural gas, coal	87,186,000
Montana	Copper, silver, zinc, coal	79,261,000
Wyoming	Petroleum, coal, natural gas	78,755,000
Alabama	Coal, iron ore, cement, clay products	77,139,000
New Jersey	Clay products, zinc, cement, sand and gravel	76,764,000
Colorado	Coal, gold, lead, zinc	63,149,000
Louisiana	Petroleum, sulphur, natural gas	60,504,000
Virginia	Coal, clay products, stone, gypsum	41,038,000
Tennessee	Coal, cement, clay products, stone	38,869,000
Iowa	Coal, cement, gypsum, clay products	38,420,000
Idaho	Lead, silver, zinc, copper	31,611,000
Nevada	Copper, silver, gold, lead	26,470,000
New Mexico	Copper, coal, petroleum, zinc	25,549,000
Washington	Coal, cement, clay products, sand and gravel	22,382,000
Maryland	Coal, cement, clay products, sand and gravel	21,558,000
Wisconsin	Stone, zinc, sand and gravel, iron ore	19,205,000
Alaska	Copper, gold, silver, coal	18,286,000
Massachusetts	Stone, clay products, sand and gravel, lime	16,832,000
Florida	Phosphate rock, stone, sand, fuller's earth	16,651,000
Georgia	Clay products, stone, cement, fuller's earth	16,504,000
Vermont	Stone, slate, lime, talc	14,409,000
North Carolina	Clay products, stone, sand and gravel, feldspar	9,504,000
South Dakota	Gold, sand and gravel, stone, gypsum	7,972,000
Oregon	Cement, sand and gravel, stone, clay products	7,827,000
Connecticut	Clay products, stone, lime, sand and gravel	6,755,000
Maine	Stone, lime, clay products, slate	5,839,060
South Carolina	Clay products, stone, sand and gravel, barite	3,508,000
New Hampshire	Stone, clay products, sand and gravel, feldspar	3,465,000
Nebraska	Cement, sand and gravel, clay products, stone	3,359,000
North Dakota	Coal, clay products, sand and gravel	2,662,000
Mississippi	Sand and gravel, clay products, stone	2,172,000
Rhode Island	Stone, clay products, sand and gravel, lime	1,152,000
Dist. of Columbia	Sand and gravel, clay products, stone	955,000
Delaware	Clay products, stone, sand and gravel	539,000

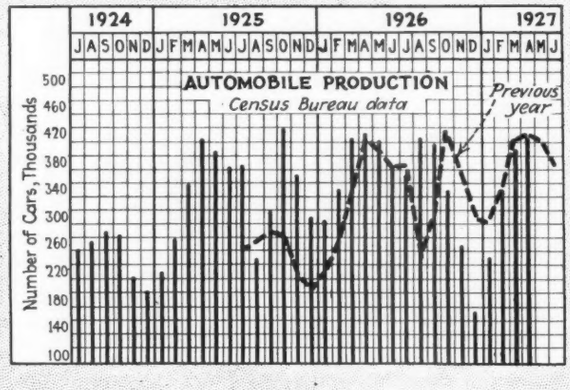
Indicators of Industrial Activity

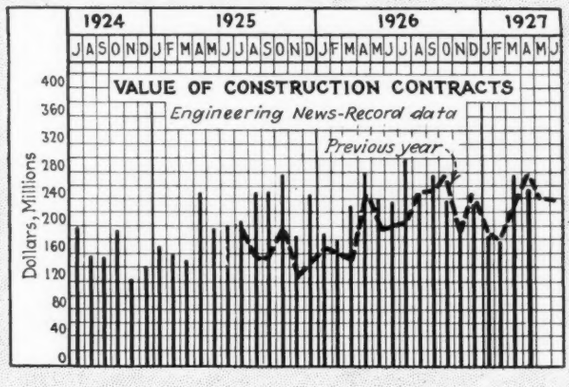
of Significance to Mining

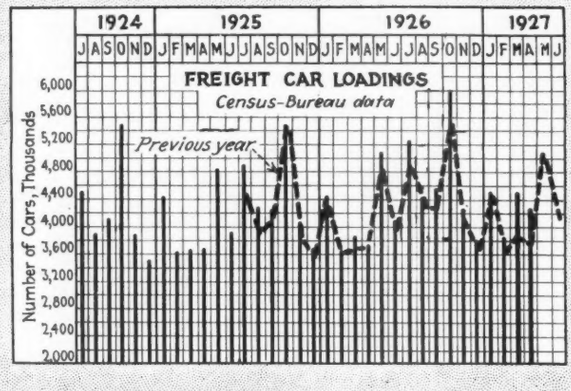

1926
1927
O N D J F M A M J J A S
E. & M. J. BAROMETER OF PRODUCTIVE OPERATIONS IN METAL MINING INDUSTRIES
Monthly Average Oct.-Dec. 1926=100
130 125 120 115 110 105 100 95 90 85 80 75 70 65
Monthly average Oct-Dec. 1926=100
Based Upon the Monthly Consumption of Electrical Energy Adjusted for Number of Days in Month.

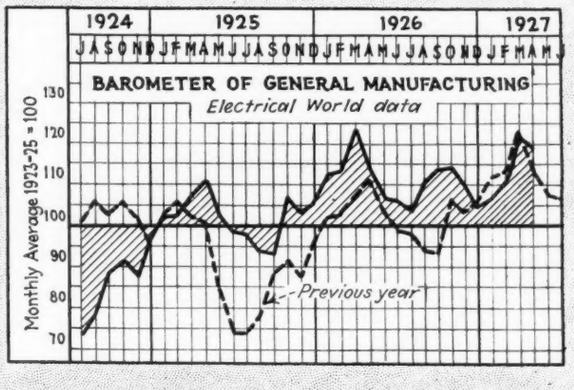

1924 1925 1926 1927
PIG IRON PRODUCTION
Census Bureau data
Previous year
Gross Tons, Thousands
5,000 4,600 4,200 3,800 3,400 3,000 2,600 2,200 1,800 1,400 1,000


1924 1925 1926 1927
PETROLEUM PRODUCTION
Census Bureau data
Previous year
Barrels, Millions
70 68 66 64 62 60 58 56 54 52 50


1924 1925 1926 1927
AUTOMOBILE PRODUCTION
Census Bureau data
Previous year
Number of Cars, Thousands
500 460 420 380 340 300 260 220 180 140 100


1924 1925 1926 1927
VALUE OF CONSTRUCTION CONTRACTS
Engineering News-Record data
Previous year
Dollars, Millions
400 360 320 280 240 200 160 120 80 40 0


1924 1925 1926 1927
FREIGHT CAR LOADINGS
Census-Bureau data
Previous year
Number of Cars, Thousands
6,000 5,600 5,200 4,800 4,400 4,000 3,600 3,200 2,800 2,400 2,000


1924 1925 1926 1927
BAROMETER OF GENERAL MANUFACTURING
Electrical World data
Monthly Average 1923-25 = 100
130 120 110 100 90 80 70
Previous year

The Market Report

Copper Breaks Through 13c.—Zinc and Lead Likewise Decline—Business Quiet

New York, May 18, 1927—None of the non-ferrous metal markets has been active during the week ending today, and prices for each of the major metals are lower. Copper can be had today at 12.875c. in Connecticut, zinc at 6c. in St. Louis, and lead at 6.60c. in New York. These are new low levels for both zinc and lead for several years. Platinum has weakened further, whereas antimony, quicksilver, and tin have shown little net change.

Little Interest in Copper

Last Thursday a fair business was done in copper at 13c. delivered in the Connecticut valleys. Since then, however, buyers have shown practically no interest in the market. Small sales have been made at 13c. in the East and 13¼c. in the Middle West; and today first hands have sold at 12.875c. and 12.925c. for Connecticut. Although producers, until today, had held consistently at 13c.—some of them are still asking this figure—a fair tonnage of second-hand metal for May delivery has changed hands at prices ranging from 12.825c. to 12.875c. Various interpretations are placed on the April statistics that appeared last Thursday, but it is clear that consumers are not greatly impressed. One interesting comparison shows that the average rate of world production for November, December and January was about 5 per cent higher than it has been during February, March and April. Although there was a sizable decline in stocks of both blister and refined at the end of April, the rate of mine production was a trifle higher in April than in March. However, producers for the most part are keeping sales in step with production and hope to prevent any serious decline in the price. Foreign business has been quiet, with Copper Exporters, Inc., maintaining its price at 13.35c. c.i.f.

Lead Weak at Lower Prices

Lead has sold in reasonable volume during the last week, though it has been distinctly a buyers' market. The American Smelting & Refining Co. maintained its New York contract price at 6.75c. until Monday, when, on hearing of price concessions by other sellers, it was reduced to 6.65c. The reduction was accepted as a matter of course by buyers and did not stimulate business to any great extent. With the St. Louis market down to 6¼c., there would seem little reason for anyone paying more than 6.60c., New York basis, for the freight rate from St. Louis is only 35c. per 100 lb. Most of the buying has been for May shipment, though producers would gladly sell for two or three months ahead at the same price. Battery manufacturers continue conspicuous by their absence from the market.

At present levels Mexican ore lead naturally goes abroad, so that the United States is called upon to consume only its own production, but, even so, it may be necessary to curtail production to maintain the present market. There seems to be a slight curtailment in the smelters' intake so far in May. Foreign demand for lead seems somewhat improved.

Zinc at 6c.

In spite of a great deal of talk of curtailment, zinc miners in Joplin continue to produce about 13,500 tons of concentrate per week, against sales of about half that quantity in each of the last two weeks. The price for "jack" has been cut to $38 per ton, and it is possible that material curtailment will be brought about soon. Price of slab zinc has declined from day to day during the week, with the bulk of the business yesterday and today being done at 6c. High-grade is nominally at 8c. in the eastern district.

Spot Tin Still Scarce

Buying of tin has been spotty, with no great excitement in the market. Spot supplies continue almost unobtainable, so the prices are largely nominal. August tin can be obtained at concessions of 3 to 4c. from the prices asked for spot. Quotations for 99 per cent tin cover delivery in a week

Daily Prices of Metals

May	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
12	12.775	63.875	67.375	6.75	6.35@6.375	6.05@6.10
13	12.75	63.625	67.25	6.725@6.75	6.35	6.05@6.075
14	12.75	63.75	67.375	6.70 @6.75	6.35	6.05@6.075
16	12.75	62.875	66.50	6.65	6.30	6.00@6.05
17	12.70	62.75	67.00	6.60@6.65	6.25	6.00@6.05
18	12.65@12.70	63.25	67.375	6.60@6.65	6.25	6.00
	12.733	63.354	67.146	6.685	6.310	6.042

Average prices for calendar week ending May 14, 1927, are: Copper, 12.767c.; 99 per cent tin, 64.125c.; Straits, 67.729c.; N. Y. lead, 6.742c.; St. L. lead, 6.373c.; zinc, 6.100c.; and silver, 56.083c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis: i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for ordinary forms of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per pound is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

May	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
12	55 1/4	55 13/16	61 1/2	295 3/4	286 1/2	25 5/16	25 15/16	29 5/16	29 7/16
13	55 1/16	55 5/8	61 1/2	293 1/4	285 1/8	25 7/16	25 15/16	29 1/4	29 3/8
16	54 13/16	55 3/8	61 1/8	290 5/8	283 1/8	25 1/8	25 5/8	29 1/8	29 3/16
17	54 7/16	55 1/16	61	290 3/4	283 1/4	24 7/8	25 3/8	28 7/8	28 15/16
18	54 9/16	55 3/16	61	292 5/8	284 3/4	25	25 9/16	29 1/16	28 15/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

May	Sterling Exchange "Checks"	Silver		Gold London	May	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
12	4 85 7/16	56 1/8	26	84s11 1/2d	16	4 85 1/8	55 7/8	25 13/16	84s11 1/2d
13	4 85 7/16	56 1/8	26	84s11 1/2d	17	4 85 1/8	55 7/8	25 15/16	84s10 1/2d
14	4 85 1/8	56	25 15/16	.....	18	4 85	55 7/8	25 7/8	84s11 1/2d
					Avg.		55.979		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

or two. Spot 99 per cent is unobtainable in any quantity.

Foreign Exchange

Closing cable quotations on the principal foreign exchanges on Tuesday, May 17, were: Francs, 3.91¼c.; lire, 5.49c.; and marks, 23.695c. Canadian dollars, ⅛ per cent premium.

Silver Steady at 55⅞c.

The silver market has been quiet and steady during the last week. Small buying orders from India and the reluctance on the part of sellers to make offerings have been the cause of this steady undertone, although the future tendency appears weak.

Mexican Dollars (Old Mexican pesos): May 12th and 13th, 42½c.; 14th, 42⅜c.; 16th, 17th and 18th, 42¼c.

Other Metals

Quotations cover large wholesale lots unless otherwise specified. London prices are according to latest mail advices.

Aluminum—Per lb., 98 or 99 per cent grade, price of leading interest, 26c.; outside market, 25.30@25.80c. London, 98 per cent, £105@£107 per long ton for domestic consumption. Heavy imports unsettle British market.

Antimony—Per lb., duty paid, New York: Chinese brands, spot business at 12½c.; July arrival about same level. Cookson's "C" grade, spot, 18c. Market dull. Needle antimony nominally 8c. for lump and 10c. for powdered. White oxide, 16½c.

Bismuth—Per lb., New York, in ton lots, $2.20@$2.25. London, 8s.

Cadmium—Per lb., New York, 60c. London, Australian metal selling freely at 1s. 10d.

Iridium—Per oz., $107@$112 for 98 @99 per cent sponge and powder.

Nickel — Per lb., ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent grade). London, £170@£175 per long ton, according to quantity.

Palladium—Per oz., $53@$57. Small lots bring up to $60. Pure metal as a constituent of crude platinum, nominal.

Platinum — Official price quoted by the leading interest on small miscellaneous orders for refined metal, $86. Open market cash sales of large lots, in New York, $71@$75. Pure metal as a constituent of crude platinum, nominal. Market remains dull with price tendency downward.

London, £18@£19 per oz. for refined and £17@£18 for crude. Dull.

Quicksilver — Per 75-lb. flask, $124@$125. Steady. Demand good. San Francisco, $126. London, £22½@£23.

The prices of **Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tellurium, Thallium, Tungsten,** and **Zirconium** are unchanged from the issue of May 7.

Metallic Ores

Manganese Ore—Per long ton unit of Mn, c.i.f. North Atlantic ports, minimum 47 per cent Mn, 36@38c. Caucasian (washed), 53@55 per cent, 38@40c. Business dull. Chemical grades unchanged from quotations in the May 7 issue.

Tungsten Ore — Per unit of WO_3, N. Y.; Wolframite, $10.50@$10.75; Western scheelite, $11@$11.25. Dull; prices largely nominal.

Chrome, Iron, Molybdenum, Tantalum, Titanium, Uranium, and Vanadium Ores are unchanged from quotations in the May 7 issue.

Zinc Blende Price Lowered—Lead Ore Unchanged

Joplin, Mo., May 14, 1927

Blende	
High	$44.60
Premium blende, basis 60 per cent zinc	$39.00@ 40.00
Prime Western, basis 60 per cent zinc	38.00
Fines and slimes, 60 per cent zinc	37.00@ 34.00
Average settling price, all zinc	39.45
Galena	
High	$91.80
Basis 80 per cent lead	85.00
Average settling price, all lead	88.04

Shipments for the week: Blende, 11,346; lead, 1,811 tons. Value, all ores the week, $607,050.

Sellers disposed of only 6,340 tons last week, and information at mid-afternoon today indicates a like shortage of sales this week. There is a slight difference, as buyers are making an effort to secure a tonnage, whereas last week the market was exceedingly apathetic. Production has declined to approximately 13,000 tons and will be further reduced next week, according to present indications. One smelting company, a producer of a large tonnage, is shipping and selling. Another smelting company, also a heavy producer, is neither shipping nor selling its ore. Other companies producing a large tonnage decline to accept the offers of the last two weeks. Unless a drastic restriction comes quickly the reserve stock in the bins may climb to a point that will become a menace and further depress the ore market.

Though lead is nominally reported selling on $85 basis, a strong rumor prevails that a higher price is being paid. The drop to 1,811 tons shipment suggests that some producers are holding their ore.

Platteville, Wis., May 14, 1927

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$41.75
Lead Ore	
Lead, basis 80 per cent lead	$85.00

Shipments for the week: Blende, 1,312 tons; lead, 40 tons. Shipment for the year: Blende, 24,820; lead, 680 tons. Shipments for the week to separating plants, 2,310 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fullers Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz, Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and **Zircon** are unchanged from prices in the May 7 issue.

Mineral Products

Arsenious Oxide (White Arsenic)—3¾c. per lb. Quiet. London, Cornish white, per long ton, £16½.

Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), Sodium Nitrate and **Zinc Oxide** are unchanged from prices in the May 7 issue.

Ferro-Alloys

Ferrochrome—Per lb. of contained chromium, 60@70 per cent chromium, 4@6 per cent carbon, 11½c.

Ferromanganese—Domestic and foreign, 78@82 per cent, $95 per long ton, furnace or duty paid, for delivery during first half of 1927. Spiegeleisen, 19@21 per cent, $37, f.o.b. furnace; 16@19 per cent, $35; nominal.

Ferrotungsten—$0.98@$1.03 per lb. of W contained, f.o.b. works. Market spotty.

Ferrocerium, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferro-uranium and **Ferrovanadium** are unchanged from prices in the May 7 issue.

Metal Products

Rolled Copper—Sheets, 21¾c.; wire, 15@15½c. f.o.b. mill.

Lead Sheets—Full rolled, 10¼c. per lb.; clipped, 10½c.

Nickel Silver—28¾c. per lb. for 18 per cent nickel Grade A sheets.

Yellow (Muntz) Metal—Dimension sheets, 19½c. per lb.; rods, 16½c.

Zinc Sheets—9¾c. per lb., f.o.b. mill.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and **Zirkite** are unchanged from quotations in the May 7 issue.

Steel Tonnage Holds Well, But Prices Are Lower

Pig Iron Quiet—Coke Soft at Unchanged Quotations

Pittsburgh, May 17, 1927.—On the whole the steel trade is giving a better account of itself in the matter of tonnage than was expected a month ago, but it is not doing as well as expected in the matter of prices, which have exhibited an important amount of softening. In bars, shapes, and wire products quotations have been softening for several weeks, chiefly by way of special prices extended to a wider and wider number of buyers, and open-market prices have now declined, 5c. a keg in nails to $2.50, a dollar a ton in bars to 1.85c., and $2 a ton in shapes to 1.80c., small lots of bars and shapes being still quoted at 1.90c. Plates are slightly easier, but are quotable at 1.80c. to 1.90c., as for several months.

The advanced asking prices on sheets recently announced are occasionally obtained, and minimum prices are up somewhat. The real test will come later, as consumers are covered rather generally to July 1.

Pig Iron.—Bessemer and basic grades at Valley furnaces are off 50c. on light sales, the market being quiet all along the line. Bessemer, $19; Basic, $18; foundry, $18.50, f.o.b. Valley furnaces.

Connellsville Coke.—The spot market is soft at previous quotations, $3 for furnace and $4@$4.75 for foundry, for spot shipment. Accumulations on track have decreased, and the market may soon begin righting itself.

Mining Stocks—Week Ended May 14, 1927

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	46½	45½	45½	Ap.16,May21 Q	0.75
Arcadian Consol.	Boston	*35	*25	*25		
Ariz. Com'l	Boston	6½	6½	6½	Ja. 7, Ja. 28	0.50
Calaveras	N. Y. Curb	2⅜	1⅞	1⅞		
Calumet & Arizona	New York	67½	67	67	Ma. 5, Ma. 21Q	1.50
Calumet & Hecla	Boston	16	15⅝	15⅝	My.31, Jn.15Q	0.50
Cerro de Pasco	New York	62	60⅜	61¼	Ap.14. My.2 Q	1.00
Chile Copper	New York	37½	36⅜	36⅜	Jn.3, Jn.30, Q	0.62½
Con. Coppermines	N. Y. Curb	3	1⅞	1⅞		
Copper Range	Boston	12⅜	12⅛	12⅛	Ap.2, My 2, A	1.00
Crystal Copper	Boston Curb	*27	*25	*26		
East Butte	Boston			1⅜	Dec., 1919	0.50
Granby Consol.	New York	38¼	36	38¼	May, 1919	1.25
Greene-Cananea	New York	48½	44⅜	47	Nov., 1920	0.50
Hancock	Boston	*30	*30	*30		
Howe Sound	New York	39½	38½	38½	Apr.1,Apr.15 Q	1.00
Inspiration Consol.	New York	18¾	17¾	18	Ma.17, Ap.4,Q	0.25
Iron Cap	Boston Curb	2	2	2		
Isle Royale	Boston	9⅞	9⅜	9⅞	Fe.4, Fe.19 Q	0.50
Kennecott	New York	65	64½	64⅜	Mar. 4 Apr. 1 Q	1.25
Magma Copper	New York	34	34	34	Ma.31,Ap.15,Q	0.75
Mason Valley	N. Y. Curb	1⅜	1⅛	1⅜		
Miami Copper	New York	15⅝	15¼	15½	My.2,My.16 Q	0.37½
Mohawk	Boston	39	38¼	38½	Ap.30, Jn.1 Q	1.00
Mother Lode Con.	New York	4	2½	2⅜	De.10, De.31SA	0.37½
Nevada Consol.	New York	14⅝	14⅜	14½	Ma.17,Ma 31Q	0.37½
New Cornelia	Boston	22½	22	22	My.6, My.23Q	0.50
Noranda	N. Y. Curb	24½	22⅜	24½		
North Butte	Boston	1⅞	1⅛	1⅛	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*62	*52	*59	Sept., 1926	0.03
Old Dominion	Boston	12⅛	11⅛	12⅛	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb			115	Ma.22, Apr.2 Q	1.50
Quincy	Boston	16	15⅞	15⅞	Mar., 1926	1.00
Ray Consolidated	New York	15⅛	15	15	Ap.20, Ap 30	0.25
St. Mary's Min. Ld.	Boston	22½	21⅞	22⅛	Fe.10 Ma.10	2.00
Seneca Copper	New York	2½	2⅜	2⅜		
Shattuck-Denn	Boston Curb	4⅞	4⅛	4⅛		
Tenn. C. & C.	New York	11⅜	8⅜	8⅞	My.31, Ju.15, Q	0 12½
United Verde Ex.	N. Y. Curb	24	23⅝	23⅞	Apr.6, May1 Q	0.75
Utah Copper	New York			115	Ma.17,Ma.31Q	1.50
Utah Metal & T.	Boston	1¼	1¼	1¼	Dec., 1917	0.30
Walker Mining	Salt Lake	*55	*50	*50		
NICKEL-COPPER						
Internat. Nickel	New York	59⅜	56	57⅛	Ma.17,Ma.31Q	0.50
Internat. Nickel, pfd.	New York			105	Ap.14,My.2 Q	1.50
LEAD						
Gladstone Mtn.	Spokane	*25¼	*23½	*25½	April, 1927	0.005
National Lead	New York	199½	194½	199	Jn..10,Jn.30 Q	1.25
National Lead pfd.	New York	135	130⅞	135	My.10,Jn.15Q	1.75
St. Joseph Lead	New York	40½	39¼	40	Se.10,Se.20,QX	0.75
ZINC						
Am. Z. L. & S.	New York	9¼	7⅞	8⅛	May, 1917	1.00
Am. Z. L. & S, pfd.	New York	50¼	47	48½	Nov., 1920	1.50
Butte C. & Z.	New York	5	4⅞	4⅞	De.9, De.24	0.50
Butte & Superior	New York	9⅛	9	9	Ma.15, Ma.31Q	0.50
Callahan Zn-Ld	New York	1⅝	1⅜	1⅝	Dec., 1920	0.50
Consol. Lead&Zinc'A'	St. Louis	14	13⅜	14	Ma.15, Ap.1 Q	0.25
Eagle-Picher	Cincinnati	27	26¼	26⅜	Au.15, Se.1 Q	0.40
Eagle-Picher, pfd.	Cincinnati			116	Jn.30, Jy.15 Q	1.50
New Jersey Zn.	N. Y. Curb	186	180	180	Ap.20,My.10 Q	2.00
United Zinc	N. Y. Curb			55		
Yellow Pine	Los Angeles	*25	*25	*25	Dec. 1925	Q 0.04
GOLD						
Alaska Juneau	New York	1⅜	1¼	1¼		
Argonaut	Toronto	*56	*46	*47½		
Barry-Hollinger	Toronto	*37	*29½	*32		
Carson Hill	Boston			*50		
Consol. W. Dome L.	Toronto	*9½	*7½	*7⅞		
Cresson Consol. G.	N. Y. Curb	2 1/16	1 15/16	1 15/16	Ma.31,Ap.10Q	0.10
Dome Mines	New York	8¼	8⅛	8½	Ap.18, My5.Q	0.25
Golden Cycle	Colo. Springs	†1.63	†1.60		Fe.28,Ma 10 Q	0.04
Hollinger Consol.	Toronto	20 90	20 20	20 40	My 4. My.20	0.10
Homestake Mining	New York	61	60	60	My.20,My.25M	0.50
Kirkland Lake	Toronto	1.49	1.37	1.43		
Lake Shore	Toronto	20 60	19 60	20 40	Ma.1, Ma.15	0.10
McIntyre-Porcupine	New York	26½	25½	26	My.2, Jn.1 Q	0.25
Portland	Colo Springs	†*50	†*47		Ap.6, Ap.15, Q	0.02
Rand Mines	New York			9¼	Au.23-30Am.Sh.	1.52
Teck-Hughes	Toronto	8.10	7.82	7.94	Ja.31, Fe. 1	0.05
Tom Reed	Los Angeles	*43½	*25	*43½	Dec., 1926	0.02
Tough-Oakes	Toronto	*49	*38	*44½		
United Eastern	N. Y. Curb	*36	*35	*35	July, 1924	0.05
Vipond Cons.	Toronto	1.20	1.10	1.15	Apr.1 Apr.15	0.03
Wright-Hargreaves	Toronto	13.11	11.30	12.50	Ap.15,My.2	0.10
GOLD AND SILVER						
Carnegie Metals	Pittsburgh	12⅛	12⅛	12⅛		
Con. Cortez	N. Y. Curb	*19	*16	*19		
Con. Virginia	San Francisco	*3½	*3½	*3½		
Dolores Esperanza	N. Y. Curb	*60	*45	*58	July, 1923	0.05
Premier Gold	N. Y. Curb	2 1/16	2	2	Ma.15, Ap.4Q	0.08
Tonopah Belmont	N. Y. Curb			1⅝	Ma.15, Ap.4	0.08
Tonopah Extension	N. Y. Curb			*26	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	2⅜	2⅜	2⅜	Ma.31, Apr.21	0.07½
West End Consol.	N. Y. Curb	*8	*8	*8	Mar., 1923	0.05
Yukon Gold	N. Y. Curb			*45	June, 1918	0 02
SILVER						
Beaver Consol	Toronto	1.19	1.09	1.15	May. 1920	0.03
Canadian Lorrain	Toronto	*26⅜	*20½	*25		
Castle-Trethewey	Toronto	*89	*81	*83		
Coniagas	Toronto	3.60	3.50	3 60	May, 1924	0.12½
Keeley	Toronto	1.36	1 28	1 28	Fe.28, Ma.15X	0.12
Lorrain Trout Lake	Toronto	*67	*50	*65	July, 1925	0.05
McKinley-Dar.-Sav.	Toronto	*16½	*15⅞	*15⅞	Oct., 1920	0 03

Stock	Exch.	High	Low	Last		Last Div.
SILVER—(Continued)						
Mining Corp. Can.	Toronto	3.55	3.40	3.41	De.30, Ja.15	0.12½
Nipissing	N. Y. Curb	6¼	5	6⅜	Ma.31, Ap.20 Q	0.15
SILVER-LEAD						
Ahumada	New York	3⅞	3½	3⅜	Ma.25,Ap.4,QX	0.12½
Bingham Mines	Boston	45	44⅜	44⅜	Ma.21, Ap.5 Q	1.00
Bunker Hill&Sullivan	N. Y. Curb	75	72½	75	Ap.30,My.4 MX	0.75
Cardiff M. & M.	Salt Lake	*63	*51	*51	Feb. 5, 1927	0.10
Chief Consol.	Salt Lake	2.65	2.42½	2.42½	Oc.10, No.1 Q	0.10
Consti'n Mng.&Mill'g	Spokane	*25½	*20	*25½		
Erupcion	Boston Curb	*54	*50	*50	Ma.25, Ap.2 Q	0.07½
Eureka Lily	Salt Lake	1.42½	1.35	1.42½		
Federal M. & S.	New York	121½	112	121½		
Federal M. & S., pfd.	New York	94	93	93	Fe.24, Ma.15 Q	1.75
Hawthorne Mines	N. Y. Curb	*4	*3	*4		
Hecla Mining	N. Y. Curb	14	13⅜	14	Fe.15,Ma.15 Q	0.25
Highland-Surprise	Spokane	8.75	8.00	8.50		
Iron King Mining	Salt Lake	*48	*39	*39		
Keystone Mining	Salt Lake	*30	*30	*30	Au.12, Au.26	0.07½
Lucky Jim	Spokane	*21½	*21	*21		
Lucky Tiger-Com.	Kansas City	†7.00	†6.50		My..20, 1927M	0.05
Mammoth Mining	Salt Lake			2.00	De.17, De.23,Q	0.25
Marsh Mines	Spokane	1.75	1.50	1.50		
North Lily	Salt Lake	2.95	2.90	2.92½		
Park Utah	New York	7⅛	6⅝	7⅛	Ma.15, Ap.1 Q	0.20
Plutus Mining	Salt Lake			1.80	Ja.10, J .15 Q	0.10
San Rafael	San Francisco			*24		
Silver King Coal.	Salt Lake	8.10	7.90	8.10	Ma.21, Ap.1 Q	0.25
Silversmith	Spokane	*35	*32½	*35	Oc.1, Oc.10 Q	0.02
Stratton Mines	Spokane	*42	*38	*40		
Sunshine M. Co.	Spokane	*75	*61½	*75		
Tamarack-Custer	Spokane	*29	*28	*29	Sept., 1924	0.25
Tintic Standard	Salt Lake	11.00	7.75	11.00	Ma.16, Ma.29X	0.40
Utah-Apex	Boston	5⅜	5⅛	5⅛	Oct., 1926	0.25
IRON						
Bethlehem Steel	New York	51½	50½	50½	July, 1924	1.25
Cleveland-Cliffs Iron	Cleveland	78	76½	77½	Ja.15, Ja.25 Q	1.00
Colorado Fuel & Iron	New York	92⅜	86	86⅜	May, 1921	0.75
Gt. North'n Iron Ore	New York	20¼	19	19¼	Dec.6, Dec.28	0.75
Inland Steel	New York	44	42½	43⅜	My. 13, Jn.1 Q	0.62½
Replogle Steel	New York	11½	9⅜	10¼		
Republic I. & S.	New York	66½	64½	65	My.14 Jn. 1 Q	1.00
Republic I. & S. pfd.	New York	104½	103½	104½	Jn 14, Jy.1 Q	1.75
Sloss-Sheffield S. & I.	New York	128½	126	127	Ma.10, Ma.21 Q	1.50
Sloss-Shef. S.&I. pfd.	New York	106½	106	106½	Ma 21, Ap.1 Q	1.75
U. S. Steel	New York	171½	168	170½	Jn.7, Jn 29 Q	1.75
U. S. Steel pfd.	New York	123⅜	121½	122⅜	My.2,My.28, Q	1 75
Virginia I. C. & C.	New York	48½	48½	48½	Jan., 1924	1.50
Virginia I.C.&C.pfd.	New York			60½	De.15, Ja.2,	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol	New York			30½	Ja 26, Ja 29	1.45
So. Am. G. & P. New	N. Y. Curb	20½	20	20½		
Alum.Co.of Amer.	N.Y.Curb	69	69	69⅜		
Alum. Co. of Amer pf.	N.Y.Curb	104	104	104	Ma.15,Ap.1 Q	1.50
Vanadium Corp.	New York	48½	46	46	My 2. My.16Q	0.75
Patino M. & E.	New York	22⅜	21¾	22½	Ap.27, My.5	1 sh.
ASBESTOS						
Asbestos Corp.	Montreal	21½	20	20	Jan., 1926	1.50
Asbestos Corp., pfd.	Montreal	87	85½	85½	Ma.31,Ap.15 Q	1.75
SULPHUR						
Freeport Texas	New York	70½	67	68	Ap.15, My.2 Q	1.00
Texas Gulf	New York	64⅜	62½	62½	Ma.1, Ma.15Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	42½	41⅞	42	My.20, Ju.1 Q	0.75
Amer. Metal pfd.	New York	110½	110½	110½	My.21, Ju.1 Q	1.75
Amer. Sm. & Ref.	New York	151⅜	148	149½	Ap.14, My.2 Q	2.00
Amer. Sm.&Ref.pfd.	New York	125	125	125	My.6, Jn.1 Q	1.75
Consol. M. & S.	Montreal	253	250½	252	De.31, Ja.15 X	6.25
Federated Metals	N. Y. Curb	12	10	12		
Newmont Mining	N. Y. Curb	75½	74⅜	74⅜	Ma.31 Ap 15 Q	0.60
U. S. Sm. R. & M.	New York	37⅜	36½	36½	Ap.7 Ap.15 Q	0.87½
U. S. Sm. R.&M.pfd.	New York	48½	47⅜	48	Ap.7, Ap.15, Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

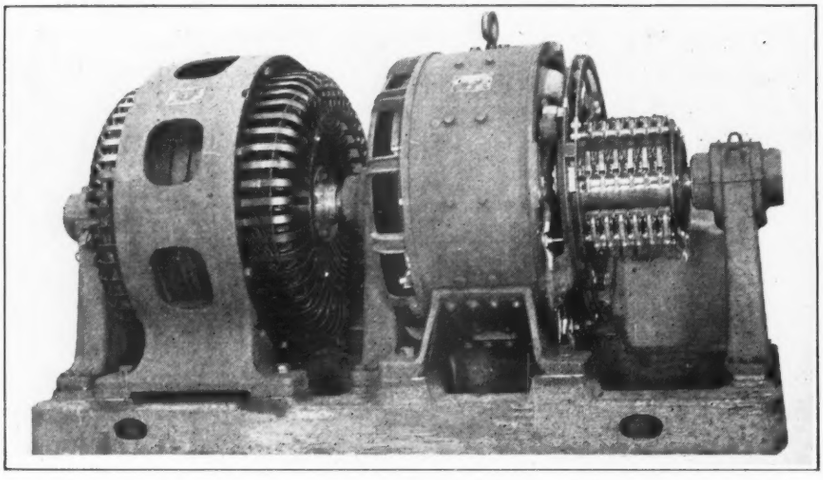
Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED May 3, 1927

Name	High	Low	Last		Last Div. Date	Amount
Aramayo Mines (25 frs.)	86/3	85/—	85/—	May	1927	5 p.c. (†)
British Platinum (£1)	3/7½	3/—	3/6	Feb.	1925	2½ p.c.
Burma Corpn. (10 rupees)	14/9	13/6	14/6	Feb.	1927	6 annas*
Bwana M'Kubwa (5s)	6/4½	6/—	6/3			
Camp Bird (2s)	4/7½	4/1½	4/3			
El Oro (£1)	4/4½	4/—	4/1½	Nov.	1924	2½ p.c.*
Esperanza (10s)	—/2	—/2	—/2			
Frontino & Bolivia (£1)	12/9	12/6	12/6	Jan.	1927	5 p.c.
Mexican Corpn. (£1)	10/9	9/9	10/—			
Mexico Mines of El Oro (£1)	16/1½	15/—	15/—	Dec.	1926	3¼ p.c.*
N'Changa Copper Mining	10/7½	10/—	10/—			
Oroville Dredging (£1)	6/9	6/4½	6/6	Dec.	1923	3½ p.c.
Ouro Preto (£1)	2/6	2/3	2/6	May	1925	2½ p.c.
Rhodesian Congo Border (£1)	56/—	52/6	55/—			
St. John del Rey (£1)	13/3	12/6	13/—	May	1927	3½ p.c.
San Francisco Mines (10s)	32/7½	31/9	32/3	Jan.	1927	2s.
Santa Gertrudis (£1)	17/—	16/3	16/6	Jan.	1927	3½ p.c.
Selukwe (2s. 6d.)	9/7½	8/9	9/3	April	1917	6¼ p.c.
S. Amer. Copper (2s.)	3/3	3/—	3/—	Nov.	1917	75 p.c.
Tanganyika (£1)	69/3	54/4½	55/—	Aug.	1926	7½ p.c.
Union Miniere du Haut-Katanga (Brussels)	10.875	10.200	10.275	July	1926	175 (‡)

* Free of British income tax. † Swiss frs ‡ Belgian frs. and free of taxation.

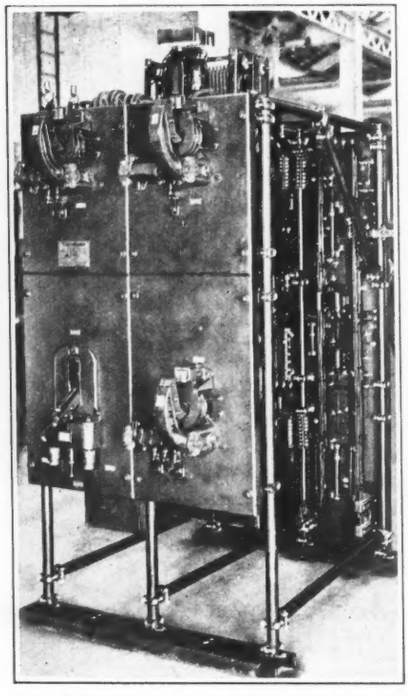
New Machinery and Inventions



Synchronous motor-generator set specially designed for automatic operation

Automatic Substation Equipment Built for Mine Service

Automatic switching equipment is being applied extensively in the mining industry, for the control of synchronous motor generators and synchronous converters. Automatic switching equipment and a synchronous motor-generator of 200 kw. capacity were on exhibit at the American Mining Congress, Cincinnati, Ohio, May 16 to May 20. The synchronous motor receives power from an incoming line energized at 2,300 volts, three phase, 60 cycle. The direct-current generator is of the 40 deg. C. mining type, is compound wound, and delivers power at the standard mining voltage of 275 volts direct current. All equipment is full automatic after the remote or panel mounted push button has been operated. Switching operations are controlled through relays by system and machine conditions. The direct-current feeder equipment is of the automatic service-restoring contactor type.



Improved automatic switching equipment

The automatic mining substation embodies all the outstanding features of the Westinghouse automatic railway substations.

Each switching operation is a direct function of the electrical condition of the converting apparatus at that particular moment, and each succeeding switching operation is dependent upon the proper functioning of the preceding operation. All switching operations are dependent upon a mechanical timing element or mechanical sequence of operation. All of the induction-type element relays are unaffected by wide variations in temperature.

Protection is provided against troubles such as phase reversal, phase failure, low voltage, alternating-current overload and short circuit, sustained overload, overheating of machine windings due to single-phase operation, overheating of the auto-transformer, failure to complete the starting sequence, failure of the synchronous motor field, direct-current overload and short circuit, direct-current reverse current, direct-current reverse polarity, overheating of the machine bearings, overspeed of the machine and restarting, until the speed and voltage of the machine have been reduced to a safe restarting value.

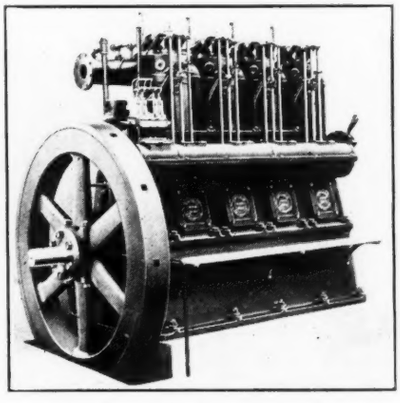
Six years of service in the industry have demonstrated that automatic switching equipment furnishes the most reliable, economical and satisfactory means for controlling mining substations. The mine operator's confidence in automatic control has increased until manual operation is considered only in a few special applications.

Trolley Splicer

Type SL splicer designed by the Westinghouse Electric & Manufacturing Co. combines ease of installation with high mechanical strength and low electrical resistance. The wire groove is straight, and the splicer may be slipped entirely over one piece of wire when making a splice. The wire is held by $\frac{7}{16}$-in. cup pointed setscrews threaded through non-ferrous nuts. These nuts are free to rock, and the greater the pull on the wire the tighter the setscrews are drawn. This insures high mechanical strength and low electrical resistance. The splicer may be used many times.

New Diesel Line Introduced

A new line of MWM Benz Diesel engines of from 80 to 240 hp. at 327 r.p.m. is now being marketed by the Chicago Pneumatic Tool Co. In presenting this high-compression Diesel engine to the trade the manufacturers point out that it is generally accepted that German engineers have led in the development of the design of engines of the Diesel type, whereas American engineers have led in mass production of machinery. A combination of desirable features was effected when the rights for manufacturing the Motoren Wereke Mannheim Benz solid injection Diesel engine were acquired by the Chicago Pneumatic company.



Diesel engines combining latest features of design and large production advantages are available in many sizes

Catalogs

Power Plants—Worthington Pump & Machinery Corporation, 115 Broadway, New York. Equipment for power plants. Bulletin H. O. 1900. Pages, 32. Illustrated.

Welding—Smith Welding Equipment Corporation, Minneapolis. Welding and cutting equipment. 1927 Junior catalog of pocket size. Pages, 32.

Diamond Drill—Sullivan Machinery Co., Chicago, Ill. Turbinair diamond drill. Bulletin 80C. Pages, 8. Also Catalog 80-O, second edition, on diamond drilling for oil with Sullivan diamond core drills. Pages, 78.

Locomotives—Davenport Locomotive Works, Davenport, Ia. Gas electric locomotives. Pages 4.

Furnace Lining Gun—Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa. The "Adamant" gun. Eight-page bulletin.

New and Rebuilt Machinery—The Denver Metal & Machinery Co., Denver, Col. Catalog of new and rebuilt machinery, pipe, rails, and supplies. Pages, 70.